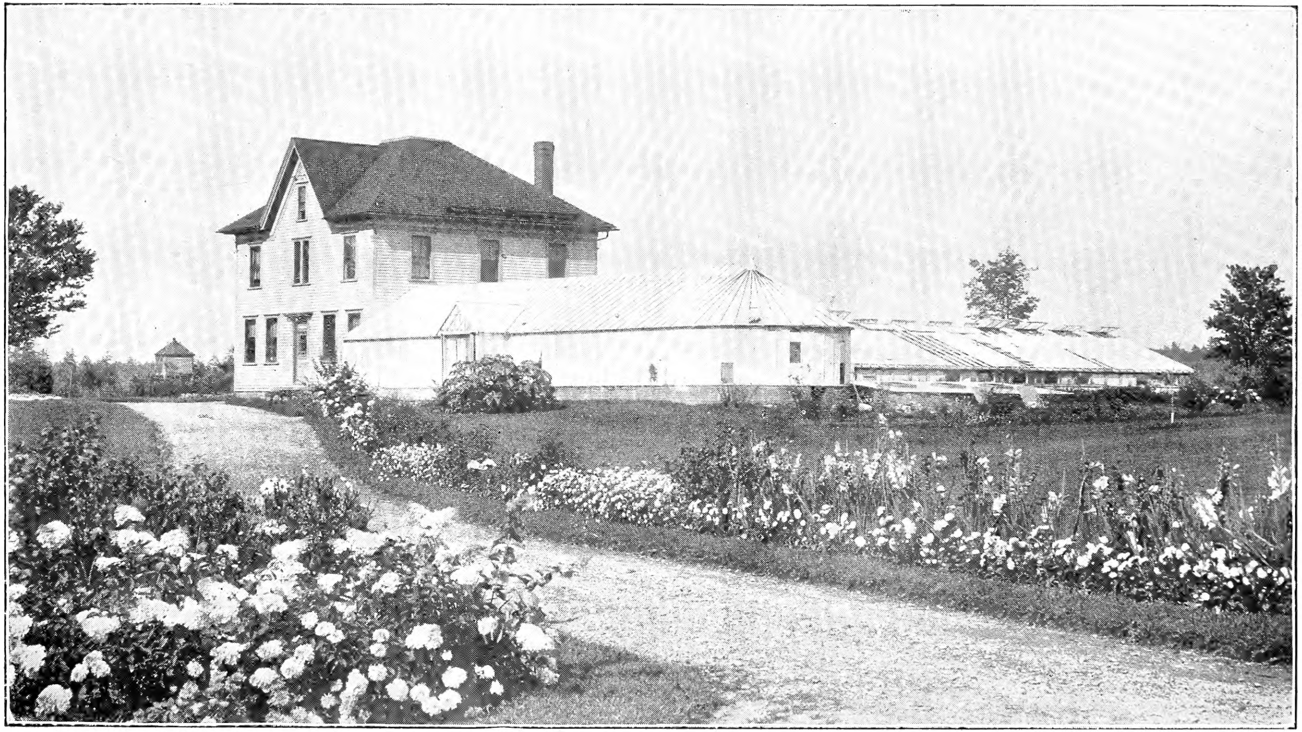

GREENHOUSES.

THIRTEENTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1897.

PART II OF THE ANNUAL REPORT OF THE UNIVERSITY OF MAINE.

AUGUSTA
KENNEBEC JOURNAL PRINT
1898

The Bulletins of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,

Orono, Maine.

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STATE OF MAINE.

A. W. Harris, Sc. D., President of the University of Maine:

SIR:—I transmit herewith the Thirteenth Annual Report of the Maine Agricultural Experiment Station for the year ending December 31, 1897.

CHARLES D. WOODS,
Director.

ORONO, Maine, December 31, 1897.

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

THE STATION COUNCIL.

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Director Charles D. Woods	*Secretary*
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Ora W. Knight	*Assistant Chemist*
Andrew J. Patten	*Assistant Chemist*
Mrs. J. Hamlin Waite	*Stenographer*

ANNOUNCEMENTS.

ESTABLISHMENT OF THE STATION.

The Maine Agricultural Experiment Station was established in accordance with chapter 294 of the Public Laws of 1885 "for the purpose of protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds, and for the purpose of promoting agriculture by scientific investigation and experiment."

In March, 1897, Congress passed an act establishing experiment stations in the several states. The Maine legislature of 1897 accepted this grant and made the Maine Agricultural Experiment Station a department of the State College or, as it now is, the University of Maine.

THE OBJECT OF THE STATION.

The purpose of the experiment stations is defined in the act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and

cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

INSPECTIONS.

In accepting the provisions of the act of Congress, the Maine legislature withdrew the state appropriation for the maintenance of the Station, and thereby did away with the original purpose of the Station so far as it related to the "protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds." In place of this, special laws regulating the sale of commercial fertilizers, concentrated commercial feeding stuffs and agricultural seeds, and the inspection of chemical glass-ware used by creameries, have been enacted, and their execution entrusted to the director of the Station.

The station officers take pains to obtain for analysis samples of all commercial fertilizers and concentrated commercial feeding stuffs coming under the law, but the organized co-operation of farmers is essential for the full and timely protection of their interests. Granges and other organizations can render efficient aid by sending, early in the season, samples taken from stock in the market and drawn in accordance with the station directions for sampling.

There is no provision made by law for the analysis of agricultural seeds. Seeds, taken in accordance with the station directions for sampling, will be examined for $1 per sample.

THE AIM OF THE STATION.

Every citizen of Maine, concerned in agriculture, farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glass-ware; to identify grasses, weeds, injurious

fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published if they prove of general interest.

STATION PUBLICATIONS.

The Station publishes annually a report covering in detail its expenses, operations, investigations and results, and bulletins giving popular accounts of the results of station work which relate directly to farm practice. The bulletins are mailed free to all citizens who request them. The annual report is bound with that of the Board of Agriculture and distributed by the Secretary of the Board. This combined report can be obtained by addressing the Secretary of Agriculture, State House, Augusta, Maine. It is usually ready for distribution in August of each year.

CORRESPONDENCE.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications should, therefore, be addressed to the

Agricultural Experiment Station,
Orono, Maine.

The post office, railroad station, freight, express and telegraph address is Orono, Maine.

The telephone call is "Bangor, 27-3."

Directions, forms and labels for taking samples, and charges for examining fertilizers, feeding stuffs and seeds for private parties can be had on application.

Parcels sent by express should be prepaid, and postage should be enclosed in private letters demanding a reply.

Remittances should be made payable to the undersigned.

CHAS. D. WOODS, Director.

ACKNOWLEDGMENTS.

Acknowledgment is hereby made for the following gifts to the Station during 1897:

One keg Laurel Green.—Nichols Chemical Company.

Seeds of Montreal Muskmelon.—R. Brodie, Montreal, Canada.

Apple cions: King, York Imperial and Tinmouth Seedling. —L. M. Macomber, North Ferrisburg, Vt.

Apple cions: Nickels Seedlings.—John Nickels, North Searsport, Me.

Apple cions: Wagener.—C. W. Taylor, Penn Yan, N. Y.

Rocky Mountain Plum and Cherry cions.—F. S. Fairfield, Orono, Ontario.

Apple cions: Monroe Sweet.—J. W. Dudley, Mapleton, Me.

Cuttings of willows, twenty-eight varieties of Cannas and ten varieties of Dahlias.—L. H. Bailey, Ithaca, N. Y.

One pound Bovee potato, one pound Sir Walter Raleigh potato, one packet Japanese millet, one packet Early Russian sunflower and one packet Early Soja Bean.—Peter Henderson & Co., New York.

Thirteen varieties of Hungarian apples.—Division of Pomology, United States Department of Agriculture.

Eight varieties of corn and one variety of peas.—F. Barteldes & Co.

One sack Damaraland Guano.—H. J. Baker & Brother, New York.

One bottle nitragin, two hundred pounds Florida rock phosphate.—Bowker Fertilizer Company.

One plow.—S. B. Hussey, North Berwick, Me.

One Excelsior Incubator.—Geo. H. Stahl, Quincy, Ill.

One Peep O'Day Incubator.—E. F. Hodgson, Dover, Mass.

One ton gluten meal.—Glucose Sugar Refining Company, Chicago, Ill.

One barrel Worcester salt.—Kimball & Whitney, Portland, Me.

The following newspapers and other publications are kindly donated to the Station by the publishers:

Agricultural Epitomist, Indianapolis, Ind.
Agricultural Gazette, Sidney, New South Wales.
American Cultivator, Boston, Mass.
American Fertilizer, Philadelphia, Pa.
American Florist, Chicago, Ill.
American Grange Bulletin, Cincinnati, Ohio.
Baltimore Weekly Sun, Baltimore, Md.
Bangor Floral, Bangor, Me.
Campbell's Soil Culture, Omaha, Neb.
Canadian Horticulturist, Grimsby, Ont.
Chronique Agricole, Lausanne, Switzerland.
Cultivator and Country Gentleman, Albany, N. Y.
Dairy World, Chicago, Ill.
Detroit Free Press, Detroit, Mich.
Elgin Dairy Report, Elgin, Ill.
Farm Reporter, Charleston, W. Va.
Farmer's Advocate, Burlington, Vt.
Farmer's Advocate, London, Ont.
Farmer's Guide, Huntington, Ind.
Farmer's Home, Dayton, Ohio.
Farm and Home, Chicago, Ill.
Farm Journal, Philadelphia, Pa.
Farmer's Magazine, Springfield, Ill.
Farmer's Review, Chicago, Ill.
Farmer's Voice, Chicago, Ill.
Farming, Dayton, Ohio.
Florists Exchange, New York, N. Y.
Forester, Princeton, N. J.
Fruit, Dunkirk, N. Y.
Gentleman Farmer, Chicago, Ill.
Green's Fruit Grower, Rochester, N. Y.
Hoard's Dairyman, Ft. Atkinson, Wis.
Holstein Fresian Register, Brattleboro, Vt.
Homestead, Des Moines, Iowa.
Horticultural Visitor, Kinmundy, Ill.
Jersey Bulletin, Indianapolis, Ind.
Journal of the Royal Agricultural Society, London, England.

Journal of the Irish Dairy Association, Limerick, Ireland.
Louisiana Planter, New Orleans, La.
Lewiston Weekly Journal, Lewiston, Me.
Maine Farmer, Augusta, Me.
Market Basket, Philadelphia, Pa.
Market Garden, Minneapolis, Minn.
Massachusetts Ploughman, Boston, Mass.
Michigan Farmer, Detroit, Mich.
Michigan Fruit Grower, Grand Rapids, Mich.
Mirror and Farmer, Manchester, N. H.
Montana Fruit Grower, Missoula, Mont.
National Stockman and Farmer, Boston, Mass.
New England Farmer, Boston, Mass.
New England Florist, Boston, Mass.
New England Homestead, Springfield, Mass.
New York Farmer, Port Jervis, N. Y.
New York Produce Review, New York City.
North American Horticulturist, Monroe, Mich.
Northern Leader, Fort Fairfield, Me.
Ohio Farmer, Cleveland, Ohio.
Oregon Agriculturist, Portland, Oregon.
Pacific Coast Dairyman, Tacoma, Wash.
Park and Cemetery, Chicago, Ill.
Practical Farmer, Philadelphia, Pa.
Public Ledger, Philadelphia, Pa.
Rural Californian, Los Angeles, Cal.
Rural Canadian, Toronto, Ont.
Rural New-Yorker, New York City.
Southern Farmer, New Orleans, La.
Southern Planter, Richmond, Va.
Southern States, Baltimore, Md.
Southwestern Farmer, Wichita, Kans.
Strawberry Specialist, Kittrell, N. C.
Turf, Farm and Home, Waterville, Me.
Vick's Magazine, Rochester, N. Y.
Wallace's Farmer, Des Moines, Iowa.
Western Agriculturist, Chicago, Ill.
The World, Vancouver, B. C.

Bulletin No. 32.

THREE TROUBLESOME WEEDS.

F. L. Harvey.

ORANGE HAWKWEED.

Hieracium aurantiacum, L.

(Order Compositae; Sunflower Family.)

HISTORY.

Orange Hawkweed, a native of Europe, was introduced into the United States a few years ago and has spread rapidly. Its occurrence in Maine has been known for over ten years. It is now widely distributed in the State and in many places has overrun grass lands, orchards, pastures and roadsides. It is sometimes grown in gardens as an ornamental plant.

DESCRIPTION.

Stem simple, erect, nearly leafless, one to two feet high, clothed with hairs, those at the top of the stem black at the base. Leaves mostly at the roots, oblong-lanceolate, toothed, hairy on both sides and without a petiole. The conspicuous heads of orange colored flowers in a flat-topped cluster at the end of the stem. Heads composed of numerous small orange colored flowers, each one of which produces at its base a small dark brown, ten-ribbed seed-like fruit, which is provided at the top with dirty white hair-like bristles, by means of which the wind spreads the numerous seeds far and wide. The plant is shown in the plate on the following page. This cut and the others used in this bulletin are from publications of the U. S. Department of Agriculture.

ORANGE HAWKWEED.

HABITS.

It is a perennial, the root stock surviving the winter. It spreads by means of runners at the base, thus rapidly extending the patch. It blossoms early, before time to cut grass. If cut early it sends up shoots from the roots which bear autumn flowers. The abundant seeds are provided with hair-like appendages which aid distribution. It monopolizes the soil, killing all grass plants and covering the surface with a dense mass of leaves. Is is not good for hay. Its only redeeming feature is its beauty, which is poor recompense for its other characters.

This plant combines all the worst features of a weed and will not yield to ordinary or careless treatment. The following precautions and remedies are suggested.

PRECAUTIONS.

Do not grow the plant in flower gardens or carry the flowers home for bouquets.

Do not buy hay or straw from farms known to be infected with it.

Do not mix the hay from infected patches with clean hay. It would be better to burn the hay from infected patches cut after the seed is mature, rather than run the risk of scattering the seed by hauling, feeding, or in manure.

Agitate the necessity of destroying patches of weeds growing along road-sides, on abandoned or neglected farms, and on waste places in towns.

Learn to recognize the plant, so as to early detect its presence on the farm and destroy it.

TREATMENT.

Cut the infested patches early before haying, if need be, to prevent early seeding, and again in the fall before the second bloom forms seed. This can be relied upon to prevent the formation of new patches by scattering seed, but will not kill the plants or prevent the spread of patches already formed. Nothing short of clean culture in some hoed crop can be relied upon to eradicate it.

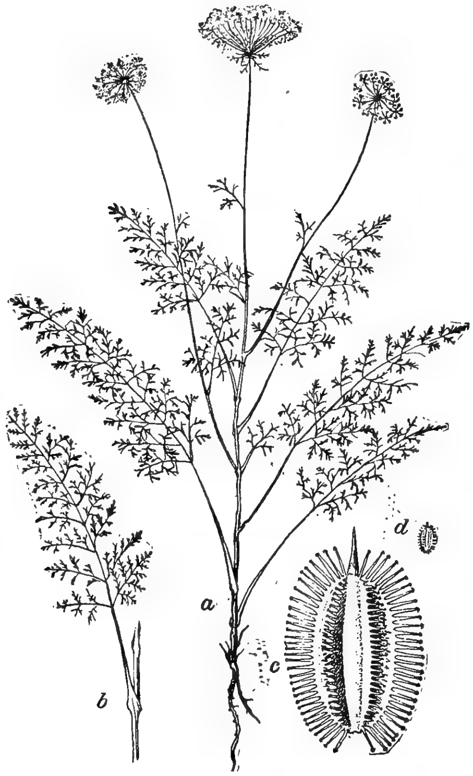
THE WILD CARROT.

Daucus Carota, L.

(Order Umbelliferae; Parsley Family.)

HISTORY.

The wild carrot is a native of Europe. It is naturalized in this country and is spreading rapidly. It is found in nearly all of the states east of the Mississippi river and also farther west. It is common in Maine in grassland, along road sides and in waste places. It has been known in the State for over ten years and has spread to many new localities and the patches in fields have become larger and more numerous. The cultivated carrot was derived from it.



DESCRIPTION.

Stem erect, one to three feet high, bristly, branching. Leaves several times compounded, ultimate divisions lance-shaped and toothed at the end. Stem leaves long, swollen at the base and clasping the stem. Ends of the branches bearing white flowers in compound umbels, which become concave in fruit. Below the flower cluster are cleft leaf-like bracts called the involucre. The bloom contracts after flowering into cup-shaped clusters of one-seeded burr-like fruits. Roots usually thickened with nourishing matter and living over winter.

HABITS.

The wild carrot is usually a biennial. It thrives in nearly all kinds of soils and climates. It flowers from June to September and does not usually seed before time to cut hay. It sends up numerous flowering shoots from the roots after haying that mature seed before frost.

The seeds are covered with a hard spiny coat which resists the weather. They are often retained in the soil for several seasons without losing their vitality. The seeds are covered with spines which become attached to the coats of passing animals, distributing them widely. The fruits remain on the stalks until after snow falls and are then broken off by the wind and blown long distances. The plant in Maine is most abundant along road sides and in neglected places from which great quantities of seeds are annually distributed to adjoining fields.

TREATMENT.

As the root is biennial, prevention of seeding for two seasons would eradicate it. The plants could be destroyed by cutting the roots off below the surface with a spade. As the plant sends out flowers from the base after haying, a single cutting would not prevent seeding. The patches should be mowed again before the second blooms are matured enough to form seeds. As sheep are said to eat it, allowing them to graze on the grasslands after haying would keep it down. The plants along roadsides and in waste places should be cut so as to prevent the seed being spread by the wind and animals.

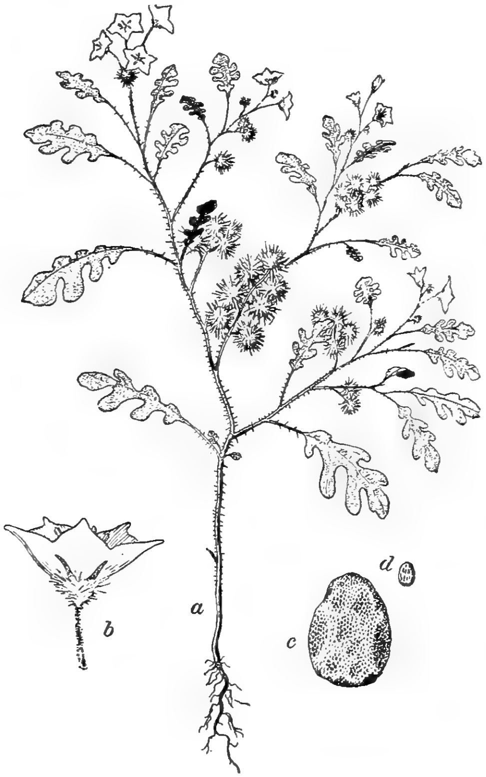
THE BUFFALO BUR.

Solanum rostratum, Dunal.

(Order Solanaceae; Night-Shade Family.)

HISTORY.

The Buffalo Bur is a native of the western plains, close to the mountains, from Mexico northward to Dakota. It was spread by buffaloes and for that reason has been called Buffalo Bur. Since the setlement of the country it has spread eastward along road sides and to long distances in seed and packing materials. It is now found in most of the states in the Mississippi valley west of the river and in many of the states farther east. It has



also appeared in Europe where it threatens to become a troublesome weed. It was detected by Mr. C. C. Carll, where western grain had been screened, at Buxton, Me., in September, 1896.

DESCRIPTION.

Stem branching, a foot or two high, horny or yellowish with copious star-shaped hairs. Leaves once or twice divided, resembling those of the water-melon. Flowers yellow, about an inch in diameter with a short tube and obtuse lobes somewhat irregular. Stamens dissimilar, the lowest longer and stouter and curved inward at the beak. Fruit enclosed and adhering to the close-fitting, very prickly calyx. Seeds thick, wavy, wrinkled. The plant is related to the Irish potato, Night-shade, Horse Nettle and Jerusalem Cherry. The plant reduced, and the flower and seed natural size, are shown in the cut which is taken from a bulletin of the United States Department of Agriculture.

HABITS.

Annual. Seeding late in northern states. Seeds not abundant. Not usual in well cultivated grounds but preferring road sides and waste places. The plant is bushy and breaks off and is blown about by the wind. It is a coarse, prickly, potato-like weed, producing round fruits covered with spines that become attached to the hair or wool of animals.

TREATMENT.

As the plant is an annual it would be destroyed in a single season if prevented from seeding. As it is liable to occur only sparingly in Maine, about railroad stations and where western grain is handled, the scattering plants may be pulled up before they seed. If it should appear in fields from sowing western grain, the patches should be carefully cut before seeding. As the plants are apt to put out flowering branches about the roots after early cutting, a second cutting may be necessary.

Bulletin No. 33.

FERTILIZER INSPECTION, 1897.

The bulletin gave the text of the law regulating the sale of commercial fertilizers, the manufacturer's guarantees and the analyses of manufacturer's samples, but as these figures are of only passing value they are omitted here.

Bulletin No. 34.

BOX EXPERIMENTS WITH PHOSPHORIC ACID FROM DIFFERENT SOURCES.

L. H. Merrill.

Probably nine-tenths of all the commercial fertilizers used in Maine are purchased in the form of "complete" or "mixed fertilizers"—that is, they contain in varying proportions nitrogen, potash and phosphoric acid. While the majority of these goods are honestly made up, yet like many of the so-called condimental foods, they are designed to cover all probable contingencies and are hence often wastefully applied. It is evident that where but one or two of the constituents named are lacking in a soil, it is not business-like to apply and pay for three. A little intelligent experimenting on the part of the farmer will often determine what is lacking. The next care is to supply this want in the most economical manner.

The use of materials containing nitrogen, phosphoric acid or potash singly is fast growing and is to be encouraged. In the choice of these materials two things are to be considered: the availability, or the readiness with which they can be used by crops, and the cost. It is the object of this bulletin to consider some of the sources of phosphoric acid, with special reference to the matter of availability.

Nearly all of the phosphoric acid used for fertilizing purposes is in combination with lime as phosphate of lime. Three forms are in common use, viz.:

1. Insoluble phosphate of lime. This is the form in which nearly all the phosphates exist in nature and from which the other forms described below are derived. The bones of animals are made up largely of this substance and are accordingly extensively used in the preparation of commercial phosphates; but the chief source of the insoluble phosphate now used in this country is rock phosphate, large deposits of which are found in South Carolina and Florida. It is insoluble in water and, unless very finely ground, its phosphoric acid is given up very slowly to the plant.

2. Soluble phosphate of lime. When the insoluble phosphate is treated with dilute sulphuric acid, a large part is converted into a form soluble in water, hence known as soluble phosphate. It is then in a condition to be immediately used by the plant. This is the most expensive of the three forms.

3. Reverted or citrate soluble phosphate of lime. If a soluble phosphate is allowed to stand for a long time it frequently happens that much of the soluble phosphate undergoes a change, passing into a form insoluble in water, but much more available to the plant than the original insoluble phosphate from which it was derived. This is the reverted or citrate soluble phosphate. It was formerly supposed to be of much less value than the soluble form, but experience has proved that this is not the case. In fact, if a soluble phosphate is added to a soil, a large part of it reverts before the crops have had time to take it up. It is known as the citrate soluble phosphate because, unlike the insoluble form, it is readily soluble in a hot solution of ammonium citrate. This reagent is therefore employed in the laboratory to distinguish the form in question. The soluble and the citrate soluble are often classed together as available.

There is another phosphate, not so generally used, in which the phosphoric acid is combined with iron and alumina instead of with lime. In its original condition it is not only insoluble in water and but very slightly soluble in hot ammonium citrate, but it is even less available to the plant than the corresponding salt of lime. A phosphate of this description is quarried at Redonda, a small island in the West Indies, and is known as Redonda phosphate or Redondite. It is a characteristic of this phosphate that at a high temperature it loses water, and at the

same time becomes largely soluble in ammonium citrate. On long standing a reverse action takes place, the phosphate passing again to the insoluble condition. It is probable that the reversion is more rapid when roasted Redonda has been applied to the soil. Comparatively little of this phosphate is sold, yet on account of the high percentage of phosphoric acid which it carries and the ease with which it may be converted into the citrate soluble condition, it would prove a valuable fertilizer if it is as available to the plant as the chemical analysis would seem to indicate.

A series of experiments has been carried on at this Station to determine the relative value of three forms of phosphatic materials to eight common crops; and also, at the same time, to determine the varying ability of different crops to appropriate phosphoric acid from the same source. The phosphates used were:

1. Acidulated Florida rock. That is, a rock phosphate that had been treated with sulphuric acid, a large part of its phosphate being thereby converted into the available form. This sample contained 20.60 per cent. total phosphoric acid, of which 16.90 per cent. was available (14.97 per cent. soluble, 1.93 per cent. citrate soluble.)

2. Crude, finely ground Florida rock (Floats), containing 32.88 per cent. total phosphoric acid, none of which was soluble, with only 2.46 per cent. soluble in ammonium citrate. This was obtained from the commercial ground rock by stirring it with water, allowing the coarse particles to subside and then pouring off the turbid water. The "Floats" were the sediments deposited from these washings.

3. A phosphate of iron and alumina (Redonda), containing 49.58 per cent. phosphoric acid, a large part of which, 42.77 per cent. was soluble in ammonium citrate.

The plants grown were peas, clover, turnips, ruta-bagas, barley, corn, potatoes and tomatoes. The experiments were conducted in the forcing house, wooden boxes being used, each containing 120 pounds of clean sand.

Ninety-six boxes were used, twelve for each kind of plant. In the first box the acid rock was used; in the second, the crude rock; in the third, the phosphate of iron and alumina; in the fourth, no phosphate. The next four boxes were treated in the

same manner, and so on to the end. Thus it will be seen that for each kind of plant there were three boxes which received the same treatment.

Such quantities of the phosphates were used that each box to which they were applied received the same total amount of phosphoric acid. To each box were also added all the ingredients that a healthy plant takes from the soil. These, together with the phosphates, were carefully mixed with the sand before it was placed in the boxes. All the conditions were made as uniform as possible in order that whatever differences were observable might fairly be attributed to the differences in the phosphates used.

When the plants were harvested they were carefully dried, weighed, and the total amount of dry matter determined for each kind of plant grown. The experiments were continued through three periods, the third period being made much shorter than the others.

In the diagram on the opposite page, the length of the black lines shows the relative amounts of dry matter produced, while the figures at the right show the actual weights, expressed in grams.

In these experiments the effect of the acid rock was very marked with all the plants grown; those receiving it, in nearly all cases, at once taking the lead and keeping it to the end. The plants were darker green in color, and the tubercles, which were developed on the roots of nearly all the leguminous plants, were larger and much more numerous. It was noticeable, however, that in some cases, especially with the clover, turnips and ruta-bagas, the good effects of the acid rock were more marked during the first few weeks of growth than at a later stage, when the roots had become more fully developed and had begun to forage for themselves. It would appear that the young plants feed but little upon the insoluble phosphates; but that the organic acids present in the sap of the roots exert a solvent action upon the insoluble phosphates in the soil, gradually converting them into available forms.

It will be noticed that in this work only the immediate effect of the phosphates has been taken into consideration, no mention having been made of the unused phosphoric acid remaining

in the soil at the close of the experiment. In actual field work the good effect of the ground rock would, of course, be far more lasting than that of the acid rock.

Diagram showing relative weights of dry matter of plants grown with phosphoric acid from different sources.

Crops.	Phosphate.	Comparative Scale.	Weight.
			Grams.
Peas	Acid Rock.		501
	Floats.		367
	Redonda.		284
	No Phosphate.		261
Clover	Acid Rock.		433
	Floats.		339
	Redonda.		252
	No Phosphate.		165
Turnips	Acid Rock.		665
	Floats.		605
	Redonda.		562
	No Phosphate.		357
Ruta Bagas.	Acid Rock.		456
	Floats.		436
	Redonda.		365
	No Phosphate.		193
Barley	Acid Rock.		1015
	Floats.		514
	Redonda.		559
	No Phosphate.		437
Corn	Acid Rock.		654
	Floats.		254
	Redonda.		294
	No Phosphate.		93
Tomatoes	Acid Rock.		406
	Floats.		276
	Redonda.		236
	No Phosphate.		108
Potatoes	Acid Rock.		779
	Floats.		562
	Redonda.		467
	No Phosphate.		452
Turnips, Roots	Acid Rock.		300
	Floats.		210
	Redonda.		270
	No Phosphate.		132
Ruta Bagas, Roots	Acid Rock.		187
	Floats.		141
	Redonda.		107
	No Phosphate.		49
Potatoes, Tubers	Acid Rock.		556
	Floats.		393
	Redonda.		419
	No Phosphate.		345

Box experiments were made at the New Hampshire Experiment Station in 1893 with winter rye, the phosphoric acid being supplied by roasted Redonda, ground bone, and basic slag. The result showed that the rye gave nearly as good returns with

the roasted Redonda as with the other phosphates. This result confirms the work here reported. It will be seen by reference to the diagram here given that the corn and barley (plants closely related to rye) gave better results with the Redonda phosphate than with the finely ground Florida rock.

SUMMARY.

1. Plants differ in their ability to feed upon crude phosphates.

2. Turnips and ruta-bagas gave nearly as good returns with the Florida rock as with the dissolved rock.

3. In nearly every other case the best results were obtained by the use of the dissolved rock.

4. Barley and corn appear to require an acid phosphate.

5. Except with the barley, corn, turnip roots and potato tubers, the crude Florida rock yielded better returns than the phosphate of iron and alumina.

6. When early maturity is desired, the acid phosphate can profitably be used.

7. The solubility of a phosphate in ammonium citrate is not always the correct measure of its actual value to the plant.

BULLETIN NO. 35.

THE CURRANT FLY. GOOSEBERRY FRUIT FLY.

Epochra Canadensis, Loew.

(Order Diptera; Family Trypetidae.)

By F. L. HARVEY.

HISTORY AND DISTRIBUTION.

This species was first considered by Loew in 1873, from a single faded female contributed by Osten Sacken. Osten Sacken's material may have come from Maine, as he gives Norway, Maine, as the locality, the specimens having been collected by S. J. Smith. Loew gives Canada as a locality upon the authority of Mr. Provancher. How long the species had been known before it was described does not appear, but

Osten Sacken says it "seems to be common in those regions." If its habit of infesting currants was known in 1873, no mention is made of it. It is next considered by Saunders in 1883. During the intervening ten years its currant infesting habit became known and some attempts were made to determine its life history.

In 1891, Prof. Gillette found it very abundant in Colorado, infesting gooseberries, this being the first authentic account of its infesting that fruit. Prof. Gillette also added many facts regarding the life history.

We find no reference to this insect in the Agricultural and Horticultural Reports of Maine, and if it has done injury heretofore it has not been recorded.

Mr. Z. A. Gilbert says he was formerly troubled by such an insect, but stopped growing currants for a time and then resumed and has not been troubled since. Mr. D. H. Knowlton, Farmington, says his currants have been infested for several years.

It is quite certain that *Epochra Canadensis,* Loew, is a native American species, distributed throughout the northern part of the United States, and in Canada, extending from the Atlantic to the Pacific coast.

This insect is widely distributed in Maine and is capable of doing great injury to currants and gooseberries and growers of these berries should become acquainted with it and be on the lookout for its depredations.

GENERAL DESCRIPTION.

Perfect insect a two-winged fly about the size of a house fly. Pale yellow or orange with greenish iridescent eyes and dark bands across the wings. Found about currant and gooseberry bushes from the last of May and through June in Maine. Stings the currants, depositing an egg under the skin, that hatches and develops into a small white maggot causing the fruit to turn red and drop prematurely. The maggots when grown leave the fallen or hanging fruit, enter the ground, and change to the pupa state from which the fly emerges the following June.

LIFE HISTORY.

The flies emerge the last of May or early in June, depending on the season and location of the bushes. The time of emergence extends over about three weeks. The flies live about a month. They mate soon after they emerge and begin laying eggs, selecting the larger currants at the base of the bunches first and depositing eggs in the others as they attain sufficient size until the eggs are all deposited. It often happens that several currants at the ends of the bunches are not affected and later develop good fruit. Usually only one egg is laid in a currant. The flies are capable of laying at least two hundred eggs and as they live only about a month must lay several every day. The fly when about to lay an egg lights on the currant and in a nervous, restless manner keeps the wings in a constant fanning motion. She often examines several currants before finding one to her fancy. Usually one of the large currants in the upper part of a bunch that is in the shade is selected. The eggs are laid one in a place at one side of the puncture made by the ovipositor and so close to the skin of the currant that they can usually be plainly seen through it. The eggs are opalescent, white, oblong and pedicilate and about one twenty-fifth of an inch long. They soon hatch into a white footless maggot with thirteen segments to the body, the head armed with a pair of black parallel retractile hooks, the rasping organs of the maggot. The larva requires about three weeks to mature, when it is about one-fourth to one-third of an inch long.

When hatched the larva is about one-twenty-fifth of an inch long and as soon as it emerges from the egg begins to travel, often leaving a delicate light colored trail close under the skin which can be seen through it. After traversing from a third to a half the distance around the currant it locates, entering in most cases one of the seeds, disappearing entirely within it. Sometimes the larva locates near the puncture and sometimes the exit hole is on the opposite cheek from the puncture. As it grows the head finally protrudes from the seed as shown in the Plate, Fig. 7. After feeding upon the contents of a seed and having grown too large to find lodgment within it, it

locates between the seeds in the pulp and then gnaws holes in the seeds, eating the contents of one after another until often half a dozen are consumed before the larva is grown. It seems to reject the coats and the clear gelatinous envelope that surrounds the seeds. The refuse of the seeds eaten turns black and becomes cemented together. A black spot becomes visible through the skin. The location of the larva can be told readily as the currant infested soon begins to show a clouded appearance where it is located and finally turns red and a black spot appears. Infested fruits ripen earlier. Often a half grown larva will be found with the head end half buried in a seed. Finally when full fed the larva gnaws to the surface and cuts a circular hole with ragged edges through the epidermis by means of which it emerges.

The larvae often leave the fruit before it drops, but fully half or more are still in the currants when they fall and remain there a greater or less time. The currants often drop before the maggots are mature. When ready to transform, they leave the currants, enter the ground under the bushes, usually less than an inch, shorten up and assume the pupa stage in which they remain, gradually transforming into the fly, until the following spring when they appear, there being but a single brood.

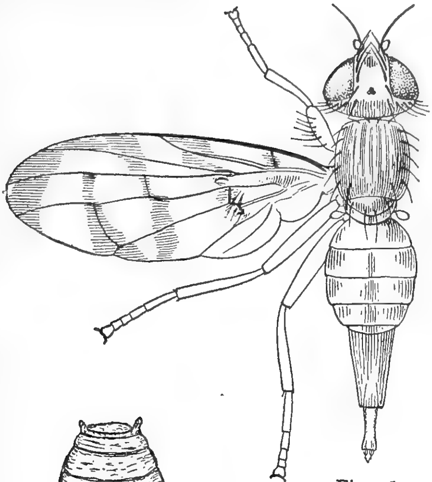


Fig. 1.

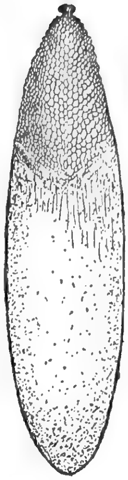


Fig. 2.

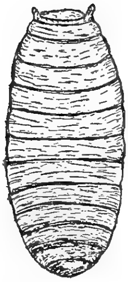


Fig. 4.

Fig. 5.

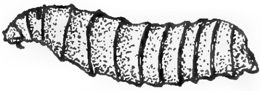


Fig. 3.

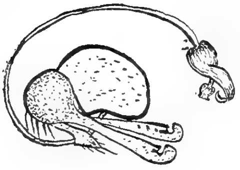


Fig. 8.

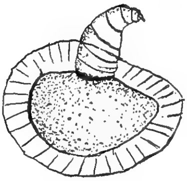


Fig. 7.

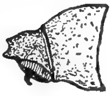


Fig. 6.

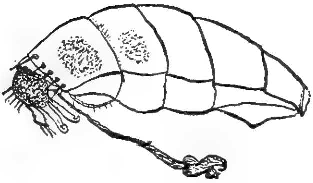


Fig. 10.

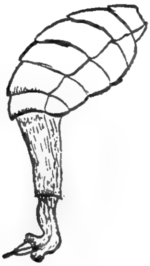


Fig. 9.

The Currant Fly, Gooseberry Fruit-Fly.

(*Epochra Canadensis, Loew.*)

EXPLANATION OF PLATE—THE CURRANT FLY.

Epochra Canadensis, Loew.

All except Figure 1 were drawn by the writer.

Figure 1. The female fly enlarged about seven and a half times. Drawn by Mr. J. H. Emerton from slides of the wing and ovipositor prepared by the writer and from pinned flies. The two basal joints of the abdomen are drawn as one. The real number, including the long terminal segment is seven instead of six.

Figure 2. Egg showing form, sculpture and pedicel, enlarged fifty times.

Figure 3. The larva enlarged about five times.

Figure 4. The pupa enlarged eight times.

Figure 5. The caudal spiracle of the larva much enlarged.

Figure 6. First two segments of the head showing the tubercles on the head, the rugose mouth and the rasping organs. Enlarged twenty-five times.

Figure 7. Seed of currant with gelatinous envelope showing larva protuding from it. Enlarged.

Figure 8. External genitalia of male. Enlarged twenty times.

Figure 9. Side view of abdomen of female with ovipositor protruding and bent backward in the position it takes as the egg is deposited under the skin to one side of the puncture. Enlarged.

Figure 10. Abdomen of male with genitalia and showing six segments. Enlarged.

REMEDIES.

We have had no experience with this insect as it is new to Maine as an injurious species. From a study of its life history we discover only one vulnerable point. The insect spends nearly eleven months of the year in the ground. In the winged stage it cannot be destroyed so far as we know. The eggs are deposited under the skin of the fruit and spraying would do no good. Part of the infested fruits drop prematurely and the worms remain in them for some time before they emerge and go into the ground. Based upon this last habit we would

recommend gathering the fallen currants frequently and burning them. This remedy cannot be relied upon to destroy *all* the flies as quite a number of maggots leave the fruit before it falls. It can be depended upon to destroy fully half if not more and can be employed to keep them in check.

Our western correspondent, Dr. W. A. Thornton, thinks that allowing young chickens about the bushes early in the season and large fowls later after the fruit is gathered will keep them in check.

As the pupae are found only about an inch below the surface, they could be destroyed with little trouble by removing the soil to that depth from under the bushes and burying it deep or depositing it on a road or some exposed place.

Deep spading and turning to bury the pupae, or stirring the surface of the soil after cold weather so as to expose the pupae are methods worth trying.

As these flies are weak and liable to perish if any obstruction is offered to prevent their coming out of the ground, we would recommend a mulching of coarse straw or hay, several inches deep, placed under the bushes and out as far as the branches extend, and well packed.

The maggots are footless and unable to crawl much. Taking advantage of this fact we intend to try this season putting a receptacle under the bushes to catch the falling maggots and infested currants when they fall. A cheap grade of tar paper will be used. Strips will be placed each side of the row and fitted closely where they meet, and an inch cleat tacked along the outer and upper edge and at the ends. The paper will slope away from the bushes. It can be made in sections and stored for use a second season. It should be put under the bushes about June 15th and remain until the worms all leave the fruit, or about August 1st, when the fallen fruit and pupae in the receptacles should be carefully collected and burned. But few of the maggots could escape this treatment.

We have not discovered any parasites to help check the pest. Short bearing years would tend to reduce the numbers.

Bulletin No. 36.

TESTING SEEDS.

Chas. D. Woods.

The law printed below was enacted last winter by the Maine legislature. The necessity for such a law is manifest. Few, however, who have not given the subject some study are aware of the extent of the inconvenience and loss to which farmers are subjected by the introduction of pernicious weeds through impure seeds. As a case in point there may be mentioned the introduction from Northern New York into West Gardiner of the King-Devil Weed, to which attention has just been called in a newspaper bulletin. This new and dangerous pest has firmly established itself in West Gardiner, has spread to the adjacent towns of Gardiner and Farmingdale, has crossed the Kennebec and has been recently reported from Winslow, twenty miles north of the point first named. The weed was undoubtedly brought in with grass seed and furnishes a good illustration of the ease with which a new pest may be established and the difficulty which may attend its eradication.

In nearly all the large countries of Europe the testing of seeds has for some years been the subject of legislative action. Seed control stations, having for their object the testing of the purity and germinative power of seeds, have been from time to time established, until there are now, in Europe alone, over one hundred in active operation. Similar stations exist also in Brazil, Java and Japan.

An Act to regulate the sale of Agricultural Seeds.

Section 1. Every lot of seeds of agricultural plants, whether in bulk or in package, containing one pound or more, and including the seeds of cereals, (except sweet corn), grasses, forage plants, vegetables, and garden plants, but not including those of trees, shrubs and ornamental plants, which is sold, offered or exposed for sale for seed by any person or persons in Maine, shall be accompanied by a written or printed guarantee of its percentage of purity, freedom from foreign matter; provided,

that mixtures may be sold as such when the percentages of the various constituents are stated.

Section 2. Dealers may base their guarantees upon tests conducted by themselves, their agents, or by the Director of the Maine Agricultural Experiment Station; provided, that such tests shall be made under such conditions as the said Director may prescribe.

Section 3. The results of all tests of seeds made by said Director shall be published by him in the bulletins or reports of the Experiment Station, together with the names of the person or persons from whom the samples of seeds were obtained. The said Director shall also publish equitable standards of purity together with such other information concerning agricultural seeds as may be of public benefit.

Section. 4. Any person or persons who shall sell, offer or expose for sale or for distribution in this state agricultural seeds without complying with the requirements of sections one and two of this act, shall, on conviction in a court of competent jurisdiction, be fined not to exceed one hundred dollars for the first offense, and not to exceed two hundred dollars for each subsequent offense.

Section 5. Any person or persons who shall, with intention to deceive, wrongly mark or label any package or bag containing garden or vegetable seeds or any other agricultural seeds, not including those of trees, shrubs, and ornamental plants, shall be guilty of a misdemeanor and upon conviction in a court of competent jurisdiction shall be fined not to exceed one hundred dollars for the first offense and not to exceed two hundred dollars for each subsequent offense.

Section 6. The provisions of this act shall not apply to any person or persons growing or selling cereals and other seeds for food.

Section 7. Whenever the Director of the Maine Agricultural Experiment Station becomes cognizant of the violation of any of the provisions of this act, he shall report such violation to the Secretary of the Board of Agriculture, and said Secretary shall prosecute the party or parties thus reported.

Section 8. All acts and parts of acts inconsistent with this act are hereby repealed.

Section. 9. This act shall take effect September one, eighteen hundred ninety-seven.

RULES FOR TESTING PURITY OF SEEDS.

"Dealers may base their guarantees upon tests conducted by themselves, their agents, or by the Director of the Maine Agricultural Experiment Station; *provided, that such tests shall be made under such conditions as the said director may prescribe.*"—Section 2 of seed law.

The following rules for testing seeds are taken from those adopted by the Association of American Agricultural Colleges and Experiment Stations. The rules which have to do with germination are here omitted, and the other rules are modified, when necessary, to conform to the requirements of the law in this State for the regulation of the sale of agricultural seeds.

Directions for Sampling Seeds.—The contents of packets should be emptied out, mixed thoroughly by stirring, and small quantities taken from different parts of the mixture to make the sample.

If seeds are in bulk or in large packages, take handfuls at random from the top, middle, and bottom, and from these, after mixing, take the sample for testing.

Samples of seeds sold under specific guaranty of quality, must be taken in the presence of a disinterested and reputable witness, who shall certify that the sample was taken in his presence according to these directions. The sample must be inclosed in an envelope or other suitable package, securely fastened and sealed with wax in the presence of the witness. The names of the sender and witness must be written on the outside of package, which shall be sent to the station prepaid.

Samples shall weigh approximately as follows:

Grasses, except noted below, 1 ounce.

Clovers and all seeds of similar size, 2 ounces.

Cereals, vetches, beet "balls" and all larger seeds, 4 ounces.

Rye grasses, bromes, sorghums, and millets, 2 ounces.

All the smaller vegetable seeds, 1 ounce.

All the larger vegetable seeds except beet "balls," 2 ounces.

Sending samples.—Every sample for test sent to the Station should be in a securely fastened package accompanied by a

statement certifying to the fairness of the sample, its source, etc. Blanks for this purpose will be furnished by the Station upon application. In case of guaranteed seed, the sample must be taken in accordance with directions given above.

Purity test.—All purity tests shall be made by weight from fair, average samples of seed. The minimum quantities to be used for this determination are named below and must be so drawn as to secure a thoroughly representative sample.

One gram: Agrostis spp., the Poas, yellow oat grass, tobacco.

Two grams: Bermuda grass, velvet grass, timothy, meadow foxtail, crested dog's tail, orchard grass, sweet vernal grass, alsike clover, white clover, Umbelliferae, and all the fescues except meadow fescue.

Three grams: All grass seed not enumerated above.

Five grams: Melilotus, Medicago spp., millet, lettuce, and all species of clover seed except white and alsike.

Ten grams: Cruciferae, flax and lespedeza.

Thirty grams: Buckwheat, Vicia spp., Lathyrus spp., beet "balls," sunflower, serradella, cucurbits, and all cereals except corn.

Fifty grams: Peas, beans, corn, lupines, cotton, and cowpeas.

Amounts to be taken of seeds not enumerated shall be the same as those required for seeds named which are of similar size.

Keeping Samples.—A sufficient amount of each sample should be kept in well-corked vials in a dark, dry and cool place for six months, to be used in case a retest is found necessary.

Record.—The record of seed tests shall include name of seed, source of sample, weight of sample, date of tests, percentage by weight and, as far as practicable, character of impurities.

Report Blank.—The following form used by the Station is recommended for reports of tests.

UNIVERSITY OF MAINE.

Maine Agricultural Experiment Station
Orono, Maine.

CHAS. D. WOODS, Director

.......................*189*....

Station No.........

Sir: The sample of seed sent to this station in a............. marked............, was received...............

It contains ......per cent by weight of seed of........., common name..........; and.......per cent of impurities.

The impurities consist of: Inert matter, ...per cent; foreign seeds, ...per cent, of which.......per cent are noxious.

Choice merchantable seed of this species should have a purity of.......per cent; and should be free from..........

Remarks ....

Respectfully,

........................*Director.*

Accessory Apparatus.—A chemical balance weighing up to 100 grams and sensitive to 1 miligram, kept in a case, together with accurate metric weights. A standard simple dissecting microscope and a large reading glass or pocket lens. Botanical forceps and dissecting implements. An authentic collection of the seeds of the principal weeds and economic plants.

The balance, microscope and forceps are indispensable to a purity test of seeds. The collection of weed seeds is very helpful.

STANDARDS OF PURITY.

In accordance with Section 4 of the pure seed law, the following "equitable standards of purity" are tentatively suggested. They are the standards adopted by the U. S. Department of Agriculture and are based upon investigations made by the Division of Botany of that Department. They are here printed without change, and include some seeds not likely to be offered in this State. For convenience of reference the percentages of vitality, as well as percentages of purity are given.

Standards of the Purity and Germination of Agricultural Seeds.

Seed.	Purity.	Germination.	Seed.	Purity.	Germination.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Alfalfa	98	85–90	Melon, musk	99	85–90
Asparagus	99	80–85	Melon, water	99	85–90
Barley	99	90–95	Millet, common (*Setaria italica*)	99	85–90
Beans	99	90–95	Millet, hog (*Panicum miliaceum*)	99	85–90
Beet	99	*150	Millet, pearl	99	85–90
Blue grass, Canadian	90	45–50	Mustard	99	90–95
Blue grass, Kentucky	90	45–50	Oats	99	90–95
Brome, awnless	90	75–80	Okra	99	80–85
Buckwheat	99	90–95	Onion	99	80–85
Cabbage	99	90–95	Parsley	99	70–75
Carrot	95	80–85	Parsnip	95	70–75
Cauliflower	99	80–85	Peas	99	93–98
Celery	98	60–65	Pumpkin	99	85–90
Clover, alsike	95	75–80	Radish	99	90–95
Clover, crimson	98	85–90	Rape	99	90–95
Clover, red	98	85–90	Rye	99	90–95
Clover, white	95	75–80	Salsify	98	75–80
Collard	99	90–95	Sorghum	98	85–90
Corn, field	99	90–95	Spinach	99	80–85
Corn, sweet	99	85–90	Spurry	99	85–90
Cotton	99	85–90	Squash	99	85–90
Cowpea	99	85–90	Timothy	98	85–90
Cress	99	85–90	Tomato	98	85–90
Cucumber	99	85–90	Turnip	99	90–95
Eggplant	99	75–80	Tobacco	98	75–80
Fescue, meadow	95	85–90	Wheat	99	90–95
Lettuce	99	85–90			
Kafir corn	98	85–90			

*Each beet fruit or "ball" is likely to contain from 2 to 7 seeds. One hundred balls should yield at least 150 sprouts.

EXAMINATION OF SEEDS BY THE STATION.

The law allows the dealer to base his guaranties upon tests made by himself, his agent or the Maine Experiment Station. As the Station has no funds available for this purpose, a charge sufficient to cover the cost of making the tests must be made. The charge for testing seeds for purity will be one dollar per sample, in the case of seeds of one kind. In the case of seeds sold in mixtures, the charge will be one dollar for the sample and twenty-five cents additional for each kind of seed said to be therein. Mixtures are difficult to separate and determine, and for this reason an extra charge is necessary. Seeds will be tested for purity for any person resident of the State, whether a dealer or not, at the above rates. The Station reserves the right to publish all results which prove of general interest.

Persons desiring to send seeds to the Station for testing can obtain on application, blanks similar to the following, on which

to describe the sample. Directions for sampling similar to those on page 34 are printed on the reverse of the blank. The receipt of the sample will be acknowledged on the day it arrives. Usually a report can be made within two or three days.

FORM FOR DESCRIBING SEED SAMPLES.

(This form must be filled out completely or the sample may be rejected.)
(Do not write here.)

Station No.... *To the Director of the Maine*
Received...... *Agricultural Experiment Station,*
Orono, Maine.

Sir: I send you to-day, marked............., contained in a ...., a fair sample of seed, drawn according to directions on the other side of this sheet.

Kind of seed..
Sold by...
At city or town of..
Name under which seed is sold.............................
The price at which it was offered for sale...............
Name of sender..
Post-office ....
County ....

**Witness: I hereby certify that the above-described sample was taken in my presence, according to the rules on the back of this sheet.*
Name ....
Address ....

* To be used when guaranteed seed is sent for test.

BULLETIN NO. 37.

FEEDING STUFF INSPECTION.

The bulletin contained the full text of the law regulating the sale of concentrated commercial feeding stuffs. The law was printed in the report for 1896, and its chief requirements are given in the article "Inspections for 1897," beyond.

Bulletin No. 38.

FERTILIZER INSPECTION, 1897.

The bulletin gave the manufacturer's guarantees, the analyses of manufacturer's samples and of samples collected by the Station, but as these figures are of only passing value they are omitted here. Under "Inspections for 1897," beyond, the requirements of the law and the way it was observed during the year are given.

Bulletin No. 39.

STOCK FEEDING SUGGESTIONS.

J. M. Bartlett.

The valuable ingredients in animal foods are ash or mineral matter, protein, fat and a class of compounds called carbohydrates, of which starch, sugar and crude fiber are the most important examples. Although the ash or mineral matter is essential to the well being of the animal, it is abundantly supplied by most materials one is likely to feed, so what one most needs to consider in buying and using cattle foods are protein, fat and carbohydrates.

A sufficient supply of protein in the food is indispensable. The working animal depends upon it to replenish and repair its working machinery, the growing animal to make muscle and build up its whole system, the sheep to make wool and the milch cow to make the casein and albumen of its milk. No other substance can take its place, or be manufactured into protein by the body. When more protein is fed than is needed for the growth and repair of the body, the excess performs the same functions as the fats and carbohydrates. As a rule, however, this is not an economical use to make of it. It is worth but slightly more than the carbohydrates and about six-tenths as much as fats for this purpose and is, commonly, the most expensive ingredient to produce or buy.

The office of the other two substances, fat and carbohydrates, is two-fold: First, they serve as fuel and are oxidized or burned in the body to supply heat and force. The fat is worth about

two and one-fourth times as much as the carbohydrates for that purpose. Second, they are used as material for making fat.

For convenience in stating the relation of protein to carbohydrate material the term nutritive ratio is used. By nutritive ratio is meant the relative amount of digestible fat and carbohydrates compared with the digestible protein. That is, if a food is said to have a nutritive ratio of 1 to 6, that means that for every pound of digestible protein it contains six pounds of digestible carbohydrate material. To find the nutritive ratio, the digestible fat is multiplied by 2¼ and the product added to the carbohydrates. This sum divided by the number of pounds of digestible protein, gives the number of pounds of carbohydrate material to one pound of protein.

It has been ascertained, by accurate experiment, that the amount of food required to keep an animal from losing weight is not materially different for different animals of the same size and species. All the food that they will *profitably* eat above that amount depends on their individual digestive and producing capacities. It is therefore evident, that a ration which would be profitable for one animal would not be for another, and no hard and fast rules can be made. For this reason the accuracy of feeding standards has been questioned by some feeders, but they certainly must be considered a vast improvement over the commonly practiced, haphazard feeding of any materials at hand. The successful and progressive feeder can, by studying his herd, learn the capacity of each animal and vary its ration from the standard to suit the individual.

The German feeding standards recommended by Wolff are the ones generally employed in this country when any standards are made use of. A so-called American standard for dairy cows, which was obtained by Woll, by means of extended correspondence with dairymen in all parts of the country and the use of averages for composition and digestibility of foods, gives a somewhat wider ration with a nutritive ratio of 1 : 6.9 and only 2.13 pounds digestible protein per day. This ration can hardly be said to be based on scientific data, and is probably too wide to give the best results in most cases. In fact some of our best dairymen in this State claim to derive the most profit from a ration having a nutritive ratio of about 1 : 4 which is much nar-

rower than the German ration and perhaps cannot be continuously fed dairy cows with safety. Authorities quite generally agree that a one thousand pound cow, of average capacity for producing milk, should have about 2.5 pounds of digestible protein per day and it would be questionable whether a Maine farmer, who is obliged to buy commercial fertilizers, could profitably feed any less to a cow of that size. At the present low prices of cotton-seed and gluten meals one can afford to feed the maximum amount of protein for the sake of increasing the value of the manure. Both of the above feeds contain fertilizing materials enough to amount to more than their cost when valued according to the valuations given to commercial fertilizers.

EXPLANATION OF TABLES.

Below are given tables which furnish the necessary data for making up rations. In table I the pounds of digestible nutrients in one hundred pounds of the coarse fodders and concentrated feeds common to this State will be found. In table II some convenient mixtures of grain are given, together with their percentages of digestible nutrients and nutritive ratios. Those with very narrow nutritive ratios are designed for feeding with such coarse fodders as timothy hay, corn silage and corn stover; while those with the wider nutritive ratio are for feeding with leguminous coarse fodders like clover hay, peas and oats, soy beans, etc. Table III gives the German feeding standards.

HOW TO USE THE TABLES.

The manner of using the tables can best be explained by an example. Suppose one wishes to make up a ration for dairy cows of 1,000 pounds live weight. For coarse fodders he has English hay and southern corn silage. By consulting table III, he finds a cow of that size needs 2.5 pounds of digestible protein, 12.5 pounds of digestible carbohydrates and 0.4 pounds of digestible fat per day. The cow will readily eat 35 pounds of silage and 10 pounds of hay. In table I he can find the percentages of digestible nutrients for southern corn silage and mixed hay. Those given for silage he multiplies by 35 and those given for hay by 10, which gives for

	Protein.	Carbohydrates.	Fat.
Southern corn silage..	.36	2.77	.16
Mixed hay	.47	4.29	.13
Total..........	.83	7.06	.29

We see from the sum of these nutrients that about 1.7 pounds more of protein, 5.5 pounds of carbohydrates and 0.1 pound of fat are needed, which can be most easily supplied with concentrated foods. Suppose we take 2 pounds each of corn meal, cotton-seed meal, gluten meal and bran. Then the percentage of nutrients of each given in the table should be multiplied by 2 which will give us a ration of the following composition:

		Protein.	Carbohy.	Fat.
Southern corn silage,	35 lbs..	.36	2.8	.16
Mixed hay,	10 " ..	.47	4.3	.13
Corn meal,	2 " ..	.12	1.2	.06
Cotton-seed meal,	2 " ..	.74	.37	.20
Gluten,	2 " ..	.67	.80	.11
Bran,	2 " ..	.25	.75	.06
Total...............		2.61	10.22	.72

TABLE I.

POUNDS OF DIGESTIBLE NUTRIENTS IN 100 POUNDS.

Coarse Fodders and Mill Products.	Protein.	Carbohydrates.	Fat.	Total nutritive substance.*	Nutritive Ratio.
Timothy	3.6	43.9	1.6	51.1	1:13.2
Red-top	4.9	45.2	1.3	53.0	1:9.8
Mixed hay (red-top, timothy & clover)	4.7	42.9	1.3	50.5	1:9.7
Hungarian	4.9	47.8	1.5	56.1	1:10.4
Orchard grass	4.9	40.6	1.4	48.7	1:8.9
Swale hay	2.4	29.5	0.8	33.7	1:13.0
Black grass	4.3	38.5	1.0	45.1	1:9.5
Oat hay	4.9	42.2	1.6	50.7	1:9.3
Oat straw	1.4	43.9	0.9	47.3	1:32.8
Corn stover	3.1	44.6	0.6	49.1	1:14.8
Maine field corn (mature including ears)	5.7	47.3	1.5	56.4	1:8.9
Maine field corn silage	1.8	13.6	0.7	17.0	1:8.4
Southern corn silage	1.0	7.9	0 4	9.8	1:8.8
Clover hay	7.2	35.8	1.8	47.1	1:5.5
Sweet corn fodder (no ears)	4.3	33.0	1.0	39.6	1:8.2
Corn meal	5.8	65.2	3.1	78.0	1:12.4
Wheat bran	12.6	37.5	3.2	57.3	1:3.5
Middlings	13.4	52.1	4.1	74.7	1:4.6
Ground oats	8.9	50.1	3.0	65.8	1:6.4
Barley	7.9	66.9	1.7	78.6	1:8.9
Pea meal	16.8	51.7	0.6	69.9	1:3.2
†Cottonseed meal	37.0	18.5	10.0	78.0	1:1.1
†Gluten meal (high in protein)	33.3	40.1	5.7	86.2	1:1.6
†Gluten meal (low in protein)	28.2	39.7	14.0	99.4	1:2.5
†Gluten feed	19.3	49.8	9.1	89.6	1:3.6
†Linseed meal	30.7	38.5	2.7	75.3	1:1.5

* Fat calculated to carbohydrate equivalent.

† These materials are subject to great variation in composition. The Feed Inspection Law now requires their composition to be stamped on the sacks, which guarantee the farmer can use, assuming the protein to be 85 per cent digestible.

TABLE II.

GRAIN MIXTURES.

Mixture Nos.	Corn meal.	Cotton seed meal.	Gluten meal.	Gluten feed.	Linseed meal.	Wheat bran.	Ground oats.	Pea meal.	Middlings.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	%	%	%	
1	200	......	300	......	......	......	......	......	......	22.3	50.1	4.7	1:2.7
2	200	100	125	......	......	......	......	......	......	21.2	46.8	5.5	1:2.8
3	100	100	......	100	......	......	......	......	......	20.7	44.5	7.4	1:3.0
4	200	100	100	......	......	200	......	......	......	17.9	44.0	4.7	1:3.1
5	100	......	......	......	......	200	......	......	......	10.3	46.7	3.2	1:5.2
6	100	......	100	......	......	100	......	......	......	17.2	47.6	4.0	1:3.3
7	100	......	......	100	......	......	100	100	......	12.7	54.2	4.0	1:5.0
8	100	100	......	......	......	100	......	......	100	17.2	43.3	5.1	1:3.2
9	......	......	......	......	100	100	100	......	......	17.4	42.0	3.0	1:2.8
10	200	......	......	......	100	......	100	......	......	12.8	54.8	3.0	1:4.8
11	300	......	100	......	......	100	......	......	......	12.7	54.6	3.6	1:4.9
12	......	......	......	......	......	100	100	100	......	12.8	46.4	2.3	1:4.0

TABLE III.

FEEDING STANDARDS PER DAY AND PER 1,000 POUNDS LIVE WEIGHT.

	Nutritive (Digestible) Substances.			Total nutritive substance.	Nutritive ratio.
	Protein.	Carbo-hydrates.	Fat.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oxen at rest in stalls	0.7	0.8	0.15	8.85	1:11.9
Oxen moderately worked	1.6	11.3	0.30	13.20	1:7.5
Oxen heavily worked	2.4	13.2	0.50	16.10	1:6.0
Horses lightly worked	1.5	9.5	0.40	11.40	1:6.9
Horses heavily worked	2.3	12.5	0.80	15.60	1:6.2
Milk cows	2.5	12.5	0.40	15.40	1:5.4
Fattening oxen	2.7	14.8	0.60	18.10	1:6.0
Fattening sheep	3.0	15.2	0.50	18.70	1:5.4
Growing cattle, age 3-6 months	3.2	13.5	1.0	17.7	1:4.9
Growing cattle, age 6-12 months	2.5	13.5	0.6	16.6	1:6.0
Growing cattle, age 12-18 months	2.0	13.0	0.4	15.4	1:7.0
Growing cattle, 2 years and over	1.6	12.0	0.3	13.9	1:7.9

RATIONS PER DAY FOR 1,000 LBS. LIVE WEIGHT, MADE UP FROM THE COARSE FODDERS AND GRAIN MIXTURES IN TABLES I AND II.

Ration Number.	Materials and Weights used for Each Ration.	Digestible Nutrients. Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
1 Milch cows.	Flint corn silage (ears glazed) ..30 lbs. Timothy hay..........................10 " Grain mixture No. 1.............. 7 "	2.5	12.0	.70	1 to 5.4
2 Milch cows.	Flint corn silage (ears glazed) ..30 lbs. Mixed hay..........................10 " Grain mixture No. 2.............. 7 "	2.5	11.7	.73	1 to 5.3
3 Milch cows.	Southern corn silage (no ears) ..35 lbs. Mixed hay..........................10 " Grain mixture No. 3.............. 8 "	2.5	10.6	.86	1 to 5.0
4 Milch cows.	Timothy hay ....10 lbs. Corn stover..........................10 " Grain mixture No. 4..............10 "	2.5	13.3	.69	1 to 5.9
5 Milch cows.	Hungarian hay......................10 lbs. Sweet corn fodder..................10 " Grain mixture No. 4 .... 9 "	2.5	12.0	.67	1 to 5.4
6 Milch cows.	Clover hay ....20 lbs. Grain mixture No. 5 ....10 "	2.5	11.8	.68	1 to 5.3
7 Oxen heavily worked.	Mixed hay .... 5 lbs. Oat hay............................ 5 " Oat straw..........................10 " Grain mixture No. 6..............10 "	2.4	13.4	.64	1 to 6.2
8 Oxen moderately worked.	Southern corn silage..............20 lbs. Mixed hay .... 5 " Oat straw..........................10 " Grain mixture No. 7..............10 "	1.9	13.5	.64	1 to 7.9
9 Horses heavily worked.	Oat hay............................15 lbs. Grain mixture No. 10 ....12 "	2.3	12.9	.60	1 to 6.2
10 Horses moderately worked.	Timothy hay......................15 lbs. Grain mixture No. 11 .... 12 "	2.1	13.1	67	1 to 7.0
11 Young growing cattle.	Mixed hay ....20 lbs. Grain mixture No. 9 ....10 "	2.7	12.8	.86	1 to 5.5
12 Growing cattle.	Mixed hay..........................10 lbs. Corn stover.......................... 5 " Southern corn silage ....15 " Grain mixture No. 12..............10 "	2.1	13.4	.45	1 to 6.4

BULLETIN NO. 40.

CELERY.

W. M. MUNSON.

Celery is a native of Great Britain where in the wild state it grows luxuriantly along wet ditches and in marshes. As a wild plant it has a long tapering root, its taste is acrid and its odor offensive. As a result of cultivation its leaf stalks have become solid, crisp and of an agreeable flavor, while in one variety—celeriac—the roots have become turnip shaped and edible.

Although not grown to an important commercial extent in Maine, the crop is one which may well be grown by every farmer and may in many cases prove a most profitable adjunct of the market garden.

SOIL.

The selection of soil in the culture of celery for profit is of great importance. The best soil is a deep black muck with an open, porous subsoil. It is upon such soil—often so soft that the work must be done by hand—that the famous Kalamazoo celery is grown. Soils of this character retain moisture well, are easily worked and are usually in such a location as to permit of controlling the water supply by means of irrigating ditches.

The soil should be at least sixteen or eighteen inches deep and a heavy clay subsoil, unless below the depth mentioned, should be avoided, as it will interfere with satisfactory banking of the crop. The swales or sloughs found on almost every farm, when drained and broken up into a state of fine tilth, make excellent celery land. If a certain amount of sand is mixed with the black soil it is all the better. Throughout the country there are many such swales which are now considered worthless, but which might be made the most profitable part of the farm.

The lack of such soils as above mentioned need not deter any one from growing the crop for home use, for though somewhat at the mercy of the weather, celery grown in uplands is more solid, keeps longer, and is less liable to suffer from frost than the

more succulent growth on black soils, and good results may be expected from any rich garden soil.

In any case, most thorough pulverizing is essential. Celery roots naturally grow near the surface, hence very deep plowing is not necessary, except on uplands where we wish to encourage deeper growth of roots the better to withstand drouth, but the young plants are small and delicate and the whole field should be prepared as for a seed bed.

FERTILIZERS.

The fact that we grow celery for its leaves, indicates that the plant food supplied should be rich in nitrogen. In most celery growing districts stable manure is preferred if it is obtainable, as the improved mechanical condition of the soil is of importance. From thirty to sixty two-horse loads of well rotted stable manure per acre are applied and at once turned under to a depth of five or six inches.

In case the manure is not well rotted or the supply is limited, some practice making a trench six or eight inches deep where the row is to stand, and, after putting in about three inches of manure, filling with soil before setting the plants.

If the stable manure is not obtainable, concentrated fertilizers may be used, if an occasional crop of clover is plowed under to supply humus. Nitrate of soda is especially valuable. Soils which have received large quantities of stable manure are also benefitted by an occasional application of lime or gypsum.

STARTING THE PLANTS.

Celery seed is at best uncertain in its germinative power, and unless the conditions are suitable the percentage of germination is usually very low. In general we may count on from 5,000 to 10,000 plants from an ounce of seed.

For early celery the seed is sown in a mild hot bed or in flats in the greenhouse about March 1 to 15. For the home garden, if no hot bed is available, seed may be sown in rich, sandy soil in a shallow box and placed in the kitchen window.

In any case, cover the seed very lightly—not more than one-sixteenth of an inch—and keep the soil moderately moist but not wet. Many practice covering the surface with paper or

with boards till the seeds begin to sprout. It is also well to soak the seeds in warm water for a few hours before sowing. There is little doubt that as a rule better results will be obtained in germinating most vegetable seeds if the soil is kept only moderately wet. Seeds must have air as well as moisture in order to germinate.

As the young plants begin to develop, transplant them into rows three inches apart, leaving about a half-inch space between the plants. In case some of the plants become too large before the ground is suitable for setting them in the field, they may be sheared back without harm. The process of "hardening off" should of course be observed. By this we mean that the plants should gradually be made accustomed to lower temperature before removal to the field.

For the main crop the seed is sown out of doors from the middle of April to the first of June. In this case a sheltered location is chosen, a fine seed-bed is prepared and the seed sown broadcast and lightly raked in, or sown thinly in drills and simply rolled. It is then well to provide a screen of lath or brush to protect the young plants and prevent destruction of the seed. If the plants are thinned somewhat in weeding, and are sheared back as they begin to grow too large, transplanting may sometimes be dispensed with, but the plants are better if handled once as described above.

If only a few hundred plants are to be grown, they may be bought cheaper than they can be raised, but if a large number are required the plants should be home grown.

CULTURE IN THE FIELD.

The plants for the main crop will be ready to transfer to the field early in July. They are usually placed six inches apart in rows five feet distant. The old practice of setting the plants in trenches is little followed at the present time.

If the rows are sufficiently far apart, the after culture is best done with a horse, but in no case should deep cultivation be permitted, as the roots extend through all the space between the rows and should not be disturbed. In short, until time of "handling," the culture need not be essentially different from that given to potatoes.

For early use the plants started in March may be transferred to the open ground about the first of June.

HANDLING.

The old custom of repeatedly "handling" or packing the earth about the growing plants has given way to more expeditious methods and it is generally conceded that one "hilling" before the final banking with earth is sufficient. This hilling should not be done till the plants have thickened considerably, about a month or six weeks before using, as after the earth is drawn about them the leaves grow tall very rapidly without increasing in diameter.

When ready to hill the plants, cultivate deeply between the rows, then draw the soil loosely about the plants with a hoe or a scraper made for that purpose. This operation makes a slight bank, not more than one-third the height of the plant, which straightens the stalks and holds them in an upright position. If the soil is in good condition, it will be unnecessary to pack the earth around individual plants by hand.

BLANCHING.

Blanching is the first step towards decay, and the exclusion of air and light and the consequent abnormal condition of the tissues render the plants, during this operation, specially liable to disease. For this reason the operation is delayed as long as possible. Plants intended for the first use are generally banked about eight or ten weeks after transplanting.

For bleaching the early crop, the use of boards is preferred to that of earth. The work is done more expeditiously, and there is less trouble from rotting. The method consists simply in placing boards about a foot wide along each side of the row with one edge close to the plants. The men then go along and raise the boards to a vertical position, placing clamps or hooks at intervals to hold them in place. A very good clamp is made by sawing two notches about an inch wide and three inches apart in a short piece of board. These clamps will then hold the boards perfectly rigid. In ten days or two weeks the celery will be ready for use and the boards are then available for use elsewhere, thus keeping up a succession.

If banking with earth is to be practiced, one of the machines made for that particular purpose will be found of advantage.

Celery intended for winter market is not usually blanched before putting into storage, though it is well to hill it up, to straighten up the leaves and make the plants compact. That intended for late fall use will of course need some attention, as from four to six weeks are required to blanch the later crop. For use before hard freezing occurs, the blanching may be done with boards, but for later use earth is to be preferred.

STORAGE.

If on well drained soil, the plants may be left in the rows till the last of November, by having some litter at hand to apply in case of hard freezing. It should be remembered, however, that if the plants are well banked, a little freezing of the tips of the leaves will do no harm, and the mistake is often made of applying winter protection too early and thus injuring the crop by keeping it too warm.

For winter storage the method in vogue in some celery-growing districts is to make, on well drained soil, beds of four to six double rows of plants with a wall of dirt between. Bank up on the outside till the tips of the leaves just show above the surface of the bed. Leave the bed in this condition till hard freezing begins, then throw two or three inches of soil over the surface. Let this soil freeze hard before applying litter, and never apply heavy covering at the first approach of cold weather. The soil in the bed is still warm, and if a heavy coat of manure is put on the top, the frost is soon taken out of the surface soil and the temperature will be high enough to induce decay. The secret of success in the winter storage of celery is to keep cool. As the severe weather of winter approaches, the covering of litter may be increased unless there is a fall of snow.

To open the beds, take the litter off from one end, break the crust of soil with a pickaxe, and remove any desired amount of the celery. Then carefully replace the covering. This plan has the merit of cheapness, and for holding plants through the winter is preferable to storage in a pit or cellar.

If the crop is to be disposed of as early as January, it may be stored in a cool cellar or pit. In this case the plants are set

very closely together on loose moist loam. To avoid heating, consequent on packing large quantities of the plants together, compartments, about two feet wide by eight or ten feet long, are made by setting up boards which shall come to the tops of the plants when in place. If the plants are closely packed, so as to exclude the air, it is unnecessary to use earth between them. When plants are stored in this way, it is important that the temperature of the pit or cellar be kept as near the freezing point as possible. If, however, it is desired to hasten the process of blanching, the temperature may be raised. The soil in which the plants are placed should be moist to prevent wilting, but the foliage should always be kept dry or there will be trouble from rotting.

ENEMIES AND DISEASES.

There are comparatively few insect enemies of celery, the most important being the "Green Lettuce Worm" and the "Parsley Worm," both of which may be destroyed by the use of kerosene emulsion.

There are several fungous diseases—such as blight, leaf spot, rust, etc.,—which, however, may be held in check by the application of dilute Bordeaux Mixture or the ammoniacal solution of copper carbonate. But in case a crop is seriously injured by one of these diseases, it is safer to grow something else on the land the next season, that any spores in the soil may be destroyed.

INSPECTIONS FOR 1897.

CHAS. D. WOODS.

The station officers take pains to obtain for analysis samples of all commercial fertilizers and concentrated commercial feeding stuffs coming under the law, but the organized co-operation of farmers is essential for the full and timely protection of their interests. Granges and other organizations can render efficient aid by sending early in the season, samples taken from stock in the market and drawn in accordance with the station directions for sampling.

There is no provision made by law for the analysis of agricultural seeds. Seeds, taken in accordance with the station directions for sampling, will be examined for $1 per sample.

Directions for sampling and blanks for forwarding samples of fertilizers, feeding stuffs and seeds will be sent on application.

FERTILIZER INSPECTION.

The marked increase in the number of brands of fertilizers offered is a misfortune. The multiplication of brands adds to the confusion of the consumer and is an expense and inconvenience to the manufacturer. Although the number of brands offered in this State is small compared with those offered in Massachusetts or New York, it is far too large. There has been a steady increase since 1894 of about 20 brands a year.

About one-third of the brands of fertilizers sold in the State were, under the law of 1893, exempt from the payment of the analysis fee, as the manufacturers claimed sales of less than thirty tons a year for these brands. The law required, however, that these non-paying brands should be inspected, consequently it was possible for a manufacturer, by selling a small amount of a large number of brands, to increase the work of inspection entirely out of proportion to the analysis fees paid.

As the cost of the inspection must be met by the receipts of the license fees, the inspection of the non-paying brands restricted the amount of inspection of the regularly licensed brands. Partly to correct this evil and partly in the hope that further increase in the number of brands offered in the State might be checked, the law was so amended that the analysis fee now applies to every brand sold in the State.

Requirements of the Law.

The full text of the amended law was printed in the report of this Station for 1896. Its chief requirements are as follows:

The Brand. Each package of commercial fertilizer shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of nitrogen.

The percentage of potash soluble in water.

The percentage of available phosphoric acid.

The percentage of total phosphoric acid.

The Certificate. For each brand of fertilizer a certificate shall be filed annually with the Director of the Station giving the manufacturer's or dealer's name, place of business, place of manufacture, name of brand of fertilizer and the guaranteed composition of the same.

The Manufacturer's Sample. Unless excused by the Director under certain conditions, a sample of each fertilizer, with an accompanying affidavit that this sample "corresponds within reasonable limits to the fertilizer which it represents" must be deposited annually with the Director of the Station. These samples are designated in the station publications as "Manufacturer's Samples."

The Analysis Fee. The law requires the annual payment to the Director of the Station of an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer, this fee to be assessed on any brand sold in the State.

Duties of the Director. The law also imposes upon the Director of the Maine Agricultural Experiment Station certain duties, which are:

The issuing of licenses to such manufacturers as comply with the above named requirements.

The analysis of the samples deposited by the manufacturer.

The selection of samples in the open market of all brands of fertilizers sold or offered for sale in the State, with the subsequent analysis of the sample.

The publication of bulletins or reports, giving the results of the inspection.

In accordance with the law, two commercial fertilizer bulletins were printed during the year. The first (33) was published early in March and contained the analyses of the samples received from the manufacturers, guaranteed to represent, within reasonable limits, the goods to be placed upon the market later. The second bulletin (38) contained the results of the analyses of the samples collected in the open market by the officers of the Station, and was published in October.

One hundred and thirty-seven brands were offered in the State during the year. The station officers analyzed one hundred and thirty-two of these; the other four were offered in small amounts and samples were not drawn, either because they were not found by the collector or because the amount found in any one place was too small to insure their fairly representing the goods.

A comparison of the percentages guaranteed by the manufacturers samples and those collected by a station representative in different parts of the State, shows that, as a rule, the fertilizers sold in the State are well up to the minimum guarantee. In a few instances the particular lots of fertilizers sampled were not quite as good as they should be; there was, however, no case which appeared to be an attempt to defraud. The comparisons indicate that the manufacturers do not intend to do much more than make good the minimum guarantee, and this is all the purchaser can safely expect.

The tabular statement which follows, summarizes the comparisons of manufacturer's and station samples with the guarantee. As a rule, the manufacturer's samples are somewhat better than those collected by the station representative.

Nitrogen.

Manufacturer's samples.

Number of samples above guarantee	110
Number of samples below guarantee	12
Average percentage of nitrogen in 110 samples above guarantee	.36%
Average percentage of nitrogen in 12 samples below guarantee	.14%
Average percentage of nitrogen in all (122) samples above guarantee	.28%

Station samples.

Number of samples above guarantee	107
Number of samples below guarantee	22
Average percentage of nitrogen in 107 samples above guarantee	.30%
Average percentage of nitrogen in 22 samples below guarantee	.21%
Average percentage of nitrogen in all (129) samples above guarantee	.22%

Available Phosphoric Acid.

Manufacturer's samples.

Number of samples above guarantee	109
Number of samples below guarantee	18
Average percentage of available phosphoric acid in 109 samples above guarantee	1.42%
Average percentage of available phosphoric acid in 18 samples below guarantee	.74%
Average percentage of available phosphoric acid in all (127) samples above guarantee	1.15%

Station samples.

Number of samples above guarantee	113
Number of samples below guarantee	19
Average percentage of available phosphoric acid in 113 samples above guarantee	1.24%
Average percentage of available phosphoric acid in 19 samples below guarantee	.78%
Average percentage of available phosphoric acid in all (132) samples above guarantee	.91%

Potash.

Manufacturer's samples.

Number of samples above guarantee	106
Number of samples below guarantee	17
Average percentage of potash in 106 samples above guarantee	.67%
Average percentage of potash in 17 samples below guarantee	.29%
Average percentage of potash in all (123) samples above guarantee	.52%

Station samples.

Number of samples above guarantee	110
Number of samples below guarantee	18
Average percentage of potash in 110 samples above guarantee	.50%
Average percentage of potash in 18 samples below guarantee	.28%
Average percentage of potash in all (128) samples above guarantee	.41%

FEEDING STUFF INSPECTION.

The legislature of 1897 passed a law entitled "An Act to regulate the sale and analysis of Concentrated Commercial Feeding Stuffs." In essence the law is identical with the law regulating the sale of commercial fertilizers, and is the first attempt to establish an adequate control over the sale of offals and other by-products used as food for cattle, and other live stock.

The full text of the law was printed in the report of this Station for 1896 and in Bulletin 37. In addition to the law, Bulletin 37 contained the following statements.

With the increased use of the by-products sold as concentrated feeds for cattle, it has been found, by chemical analysis and feeding tests, as well as by common experience, that there are great differences in the feeding values of goods which outwardly closely resemble each other. As an illustration the following case may be quoted: Some time ago the Station purchased a quantity of cotton-seed meal from a Bangor dealer. A few weeks later the firm offered at a somewhat reduced rate

a brand which, to outward appearance, was apparently equal to the first. Yet chemical analysis showed that the first contained 52.2 per cent protein and the latter only 31.9 per cent. In other words, one, which was an unusually good article, contained over 60 per cent more protein than the other, which proved much below the average. As regards the value, the actual difference was probably much greater, since the amount of ash found in the lower grade indicated that the adulterant used was of inferior quality, and the digestibility of the protein present must have been affected thereby.

In the improvement in the manufacture of gluten meals and feeds, and the increased demand for corn oil, the percentages of fat have been greatly diminished and in most glutens the percentages of protein have been correspondingly increased. The general feeling of dissatisfaction with the existing state of things came to the front at the State Dairy Meeting held in Skowhegan in December of last year, and again later at the meeting of the State Grange. At the first of these meetings the State Board of Agriculture appointed a committee to draft a law to regulate the sale of feeding stuffs. The State Grange passed resolutions urging the desirability of such legislation. At the annual meeting of the Board of Agriculture the committee presented their report, recommending the enactment of a law in all its essentials identical with the act which was finally passed in March, 1897.

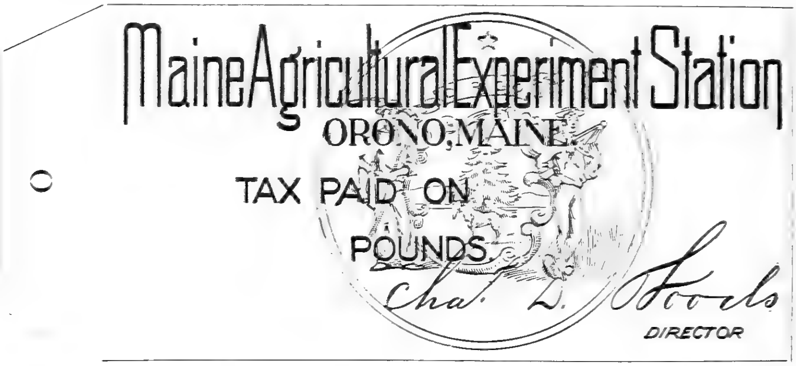
Chief Provisions of the Law.

The points of the law of most interest, both to the dealer and consumer, are concisely stated below.

Kinds of Feed coming within the Law. The law covers all feeding stuffs *except* hays and straws; whole seeds and meals of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn; brans and middlings. The principal feeds coming under the provisions of the law are linseed meals, cotton-seed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, ground beef or fish scraps, mixed feeds, and all other materials of similar nature.

Inspection Tax. In order to meet the expenses of inspection, a tax of ten cents per ton must be paid to the Director of the Maine Agricultural Experiment Station.

Inspection Tax Tag. The Director of the Station, on receipt of the inspection tax is required to furnish a tag stating that all charges have been paid. The form of the inspection tax tag to be used for the present will consist of an ordinary shipping tag, colored red, similar in design to the following:



These tags, with the number of pounds printed in, will be furnished in any quantity on receipt of the tonnage tax. The tags will be provided with strings or wires if desired. Unused tags will be redeemed at any time. Tags will be sent by express, charges for carriage to be collected.

The Brand. Each package of feeding stuff included within the law shall have affixed the inspection tax tag, and shall also bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of crude protein.

The percentage of crude fat.

These statements may be printed directly on the bag, on a tag to be attached to the package, or on the back of the inspection tax tag furnished by the Director of the Station.

A certified copy of this statement of brand must be filed with the Director of the Station.

Analysis. Whenever the Director of the Station shall so request, the certificate must be accompanied by a sealed sample of the goods so certified. It shall also be the duty of the Director to cause to be collected each year at least one sample of each of the brands of feeding stuffs coming within the provisions of this act. These samples are to be analyzed and the results, together with related matter, published from time to time in the form of bulletins.

Analyses for manufacturers, dealers and others, which are not of general interest and which are not called for by the provisions of the act, will be made on request at a price sufficient to cover the cost of analysis. The rates will be: for protein, one dollar; for fat, two dollars. Under no conditions will the Station undertake analyses the results of which cannot be published.

Although the law did not take effect till October, a copy of the above bulletin was sent in August to the entire mailing list of the Station and to all dealers whose addresses could be found in the Maine Register and who, from the nature of their business, would seem at all likely to handle feeding stuffs.

Inspectors.

In the past the Station has employed one person to collect samples in the State. Although this may prove to be the more economical method of inspection, it was deemed advisable to employ several local inspectors for the present. The following gentlemen were appointed inspectors in October and have served the Station acceptably.

Inspectors for 1897.

Arthur B. Briggs, Hartford; J. W. Dudley, Castle Hill; F. B. Elliot, Bowdoinham; A. S. Farnsworth, West Pembroke; W. G. Hunton, Readfield, Ora W. Knight, Bangor; W. H. Snow, Milo; L. O. Straw, Newfield; P. C. Wentworth, East Hiram; Chas. E. Wheeler, Chesterville; John M. Winslow, Glendon.

The law went into operation October 1. In order that dealers might have still further time to get into line with the requirements of the law, the first visit of the inspectors was deferred until after November 1. On this round the inspectors visited all dealers in their territory and reported to the

Director of the Station every one they found violating the law in any particular. These reports were made daily, and immediately upon their receipt, letters were written to the delinquents, calling their attention to their failure to comply with the law. No case of wilful violation has come to our notice. On the contrary there has been an evident desire on the part of most dealers to live up to all the requirements of the law. No samples were drawn by inspectors until January. At this time they reported very few violations of the law and it seems to be working smoothly in all respects. At the time of this writing the law is for the most part fully complied with.

The co-operation of the dealers has materially assisted in the speedy introduction of this entirely new feature in legislation. Both dealer and consumer are coming to better understand the nature of these feeds and have a clearer knowledge of their feeding values. Under date of October 1, a large commission house wrote, "It seems to us that this law must be very educational," and such it is proving itself to be. That it will be as great a benefit to both dealer and consumer as the fertilizer inspection has become, there is little doubt.

INSPECTION OF CHEMICAL GLASSWARE USED IN CREAMERIES.

Nearly all the glassware that has been examined during the year has come from dealers in dairy supplies. It is reasonable to suppose, therefore, that the butter factories have renewed their stock by purchasing tested bottles and pipettes direct from the dealers and are complying with the law in that respect.

It has been gratifying to note that a very small percentage of the goods inspected the past year was inaccurately graduated. All bottles and pipettes examined by the Station and found correct have the letters M. E. S. etched upon them. The text of the law was printed in the Report for 1896.

SEED TESTING.

The law passed by the Legislature of 1897, while it imposes certain duties upon the Director of the Station, is not an inspection law. Bulletin 36, which is reprinted on pages 32 to 38 of this Report, contains the law and rules for testing purity of seeds. This bulletin was issued in August and was sent to all dealers as well as to the regular mailing list of the Station.

TESTING DAIRY PRODUCTS BY THE BABCOCK TEST.

J. M. Bartlett.

The following pages were written with the idea of bringing together, in compact form, such information as we frequently have calls for within the limits of our own State. Notwithstanding the fact that the Station has published several bulletins on the subject, it has nothing at hand that covers all the ground. Very little that is new is presented and quite a part of the matter has been taken from other station publications. The part on testing milk is largely a reprint of Dr. Babcock's description in the Report of the Wisconsin Experiment Station for 1893.

Testing cream is given considerable attention for the reason that it is of very general interest in this State. Especial attention is called to sampling and weighing cream received at butter factories, and to a uniform system of paying for cream. Scales for weighing cream and other dairy products that cannot be accurately or readily measured for the test are suggested, and their use is earnestly recommended to all butter factories.

WHAT THE TEST SHOWS.

The Babcock Test has been before the public so many years and is so familiar to most dairymen that it seems almost superfluous to explain its object and use. Nevertheless, there are those who do not have a clear idea of just what the test means or shows, and it is for such that this brief explanation is given.

Normal milk contains from 12 to 16 per cent solid matter and 88 to 84 per cent water. The solid matter consists of fat and casein in suspension, and albumin, milk sugar and mineral salts in solution. The fat, which is practically the only valuable constituent for butter making, is the ingredient determined by the Babcock test. The sulfuric acid used in the process dis-

solves all the solids contained in the milk except the fat; this is separated from the solution by centrifugal force.

In churning, water and small quantities of casein and other solids separate with the butter fat and remain incorporated with it, so that after the salt is added butter contains only 80 to 87 per cent butter fat. In the Babcock test the fat is separated as pure butter fat, and contains neither water, salt nor casein.

A good quality of butter contains about 85 per cent butter fat, and this is the percentage commonly used in calculating but-

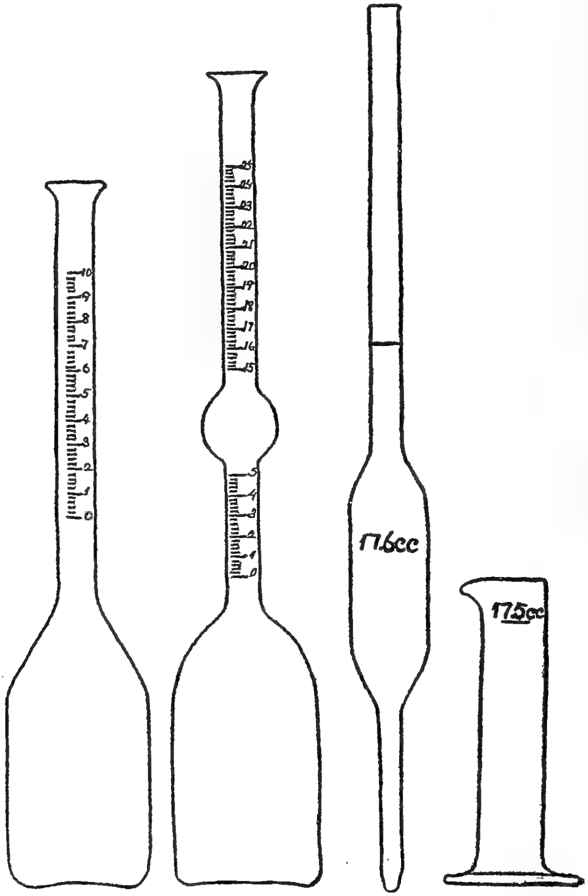


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

ter fat to its equivalent in butter. Suppose, for example, milk tests 4.25 per cent fat, 100 pounds of such milk contains 4.25

pounds of butter fat, which would make about 5 pounds of butter containing 85 per cent fat. If cream tests 20 per cent fat, 100 pounds of that cream contains 20 pounds of butter fat, which would make about 23.6 pounds of butter.

APPARATUS.

The principal apparatus used in the test is here described. Special forms and modifications used in determining the butter fat in different dairy products are given in the applications of the method to special cases.

The test bottles. The general form of the bottle is shown in figure 1 on the opposite page. Several different styles used for different purposes are described beyond. All of the bottles have graduated necks reading in percentages of the amount of milk or cream used. The dimensions of the scale on the necks should be uniform and the lines should run straight across the neck, and not obliquely, as is sometimes the case.

When new, the lines and numbers of the scale are usually blackened so that they are easily distinguished, but after the bottles have been cleaned a number of times the color may be washed away, leaving the lines indistinct. The color may be restored by rubbing the scale with a lead pencil, or with a cloth having a little black paint upon it.

In order to avoid the possibility of errors, the bottles should be numbered. This is conveniently done by having a number stamped on a copper ring which is slipped over the neck, or by having a spot etched on the upper part of the neck so that the number can be marked upon it with a pencil.

The pipette. The form of pipette commonly used is shown in the accompanying cut (fig. 3). That for milk should deliver 17.6 cubic centimeters and for cream 18 cubic centimeters, when filled to the mark.

Acid Measure. The best measure for general use is a graduate or cyclinder of glass, (fig. 4) with a lip to pour from. When filled to the mark it contains 17.5 cubic centimeters.

Several automatic pipettes and convenient devices have been invented for handling acid on a large scale for use in factories where a large number of tests must be made daily. These cost from $5 to $50 and are great time savers. Two very satisfac-

tory forms that can be obtained at a moderate price may be mentioned here, one known as the Swedish acid bottle and one offered for sale by Emil Greiner, New York City. These can be obtained from dealers in creamery supplies.

Centrifugal Machine. All machines made by reliable dairy supply firms are suitable for this purpose. A machine must be capable of making 800 to 1200 revolutions per minute, according to the diameter of the wheel. A small wheel should make more revolutions than a large one. A wheel should not be less than 16 inches in diameter and need not be more than 20. Steam turbine machines are to be preferred for factories or wherever high pressure steam is available, as they maintain an even speed, prevent cooling of the bottles and supply hot distilled water for filling. They should be furnished with a speed indicator.

Sulfuric Acid. This acid should have a specific gravity of 1.820 to 1.825. It is very important that the acid used be of the right strength. If it is too weak, the curd will not all be dissolved, and will make the test unsatisfactory. If the acid is too strong, the fat is liable to be blackened, or black particles of charred matter will accumulate just below the fat column and interfere with the reading. If the acid is only slightly too strong or weak, a little less or more than the prescribed amount may be used and give good results. It is better to have the acid right and use the amount directed.

If acid is bought in the carboy, the wooden case surrounding it should never be removed, as by so doing the risk of breakage is greatly increased. All carboys or bottles in which acid is kept must be tightly stoppered, or the acid will absorb moisture from the air and become too weak for use.

One should always use the greatest care in handling sulfuric acid as it is very corrosive, causing serious burns when allowed to remain upon the skin and destroying clothes when it comes in contact with them. When spilled upon the hands or clothing, it should be washed off immediately, using plenty of water. If the color has been changed on the clothing it can usually be restored by saturating the spot with ammonia water.

Apparatus for Filling the Bottles with Hot Water. A very convenient arrangement for this purpose consists of a galvan-

ized iron or copper tank, holding 4 to 6 quarts, with a tubulature near the bottom to which is attached a small flexible rubber tube, about 3 feet long, provided with a pinch-cock and glass or metal nozzle. For use, the tank is filled with hot water, placed on a support a foot or two above the machine; by means of the rubber tube all the bottles can then be filled without moving them from their places. The flow of water is controlled by the pinch-cock.

Sampling Tube. For this purpose several different tubes have been devised, all of which are efficient when properly used. The simplest one of all is a small metal tube about 2 feet long with a bore of about three-sixteenths of an inch in diameter. This tube is lowered slowly into the pail of milk or cream so that it will fill as it goes down, then the thumb or finger is pressed over the top opening so as to hold the contents in when the tube is taken out. The chief objection to this tube is, it has so small a bore that it holds but little cream and fills very slowly, thereby increasing the liability of letting it into the milk or cream faster than it fills and not getting a good sample.

Another form recommended by the Connecticut (Storrs) Station is a metal tube similar to the one above described with a stop-cock at the top to close it. This tube has an internal diameter of about one-fourth of an inch, bushed down to one-eighth of an inch at the lower end so the milk will not run out before the stop-cock is opened.

Still another form is the so-called Scoville Milk Sampler, which is a long metal tube with a valve at the bottom, which closes when the tube is filled with milk.

The Station uses a tube of its own design that works very satisfactorily. It consists of a brass tube about 2 feet long and five-sixteenth of an inch inside diameter. The lower opening is provided with a valve which is opened or closed by means of a small rod passing through the interior of the tube to a handle at the top. The parts are connected by screw connections so they can be readily detached and cleaned as necessary.

MAKING THE TEST.

Mixing the Sample. Every precaution should be taken to have the sample represent the milk or cream from which it is taken. Milk fresh from the cow can be thoroughly mixed by pouring three or four times from one vessel to another, but milk or cream that has stood until a layer of thick cream has formed on the top must be mixed until the thick cream is broken up and the whole mass appears homogeneous. No clots of cream should appear on the surface when the sample is left quiet for a moment. The mixing should not be too violent or carried to excess, for in this way little granules of butter may be separated or the sample filled with air bubbles, making it impossible to measure out the required quantity.

Large quantities of sour milk or cream cannot be sampled, but small lots of a pint or quart can be put in proper condition by the following treatment: Add to the sample powdered "concentrated lye" or caustic soda, (a small thimbleful to a pint of milk or cream is sufficient,) heat in a closed jar or bottle in water to about 110° to 120° F., shake thoroughly, and allow to cool to about 70° F., when it will be found to be in as good condition to measure as when fresh.

Measuring the sample for a test. When the sample has been sufficiently mixed, fill the pipette by placing its lower end in the sample and sucking at the upper end until the milk or cream rises above the mark on the stem; then remove the pipette from the mouth, and quickly close the tube at the upper end by firmly pressing the end of the index finger upon it to prevent access of air. So long as this is done the sample cannot flow from the pipette. Holding the pipette in a perpendicular position, with the mark on a level with the eye, carefully relieve the pressure on the finger so as to admit air slowly to the space above the liquid. In order to more easily control the access of the air, both the finger and the end of the pipette should be dry. When the upper surface of the liquid coincides with the mark upon the stem, the pressure should be renewed to stop the flow.

Next, place the point of the pipette in the mouth of one of the test bottles, held in a slightly inclined position so that the liquid will flow down the side of the tube, leaving a space for the

air to escape without clogging the neck, and remove the finger, allowing the liquid to flow into the bottle. After waiting a short time for the pipette to drain, blow into the upper end to expel the liquid held by capillary attraction in the point. If the pipette is not dry when used, it should be first filled with sample to be tested, and this thrown away before taking the test sample. If several samples of the same lot are taken for comparison, the material to be tested should be poured once from one vessel to another after each sample is measured. Neglect of this precaution may make a perceptible difference in the results. Persons who have had no experience in the use of the pipette will do well to practice a short time by measuring water into a test bottle before attempting to make an analysis.

Adding the Acid. After the sample has been measured into the test bottle, the test may be proceeded with immediately, or it may be left for a day or two without materially changing the result; samples that have remained in the test bottles two or three weeks, and which had commenced to mould before the acid was added, have given the same amount of fat as samples tested immediately after being measured. If the sample has become coagulated, the curd should be broken up by shaking the test bottle before the acid is added. It is advisable, when possible, that the test be proceeded with immediately after the samples are measured.

The volume of commercial sulfuric acid required for a test is 17.5 cubic centimeters. If too little acid is added, the casein is not all held in solution throughout the test, and an imperfect separation of the fat results. If too much acid is used, the fat itself is attacked. The acid need not be measured with great accuracy, as small variations will not affect the results.

When all of the samples of milk to be tested are measured ready for the test, the acid measure is filled to the 17.5 cubic centimeter mark with sulfuric acid, and then carefully poured into a test bottle containing milk. The bottle is held in a slightly inclined position, for reasons given in directions for measuring the sample. The acid being much the heavier sinks directly to the bottom of the test bottle without mixing with the milk that floats upon it. The acid and milk should be thoroughly mixed together by gently shaking with a rotary motion. At

first there is a precipitation of curd, but this rapidly dissolves. There is a large amount of heat evolved by the chemical action, and the solution, at first nearly colorless, soon changes to a very dark brown, owing to the charring of the milk sugar and perhaps some other constituents of the milk or cream.

Whirling the Bottles. The test bottles containing the mixture of the milk and acid should be placed in the machine, and whirled directly after the acid is added. An even number of bottles should be whirled at the same time, and they should be placed in the wheel in pairs opposite to each other, so that the equilibrium of the apparatus will not be disturbed. When all of the test bottles are placed in the apparatus, the cover is placed upon the jacket, and the machine turned at the proper speed for about five minutes. The test should never be made without the cover being placed upon the jacket, as this not only prevents the cooling of the bottles when they are whirled, but in case of the breakage of bottles will protect tne face and eyes of the operator from injury by pieces of glass or hot acid. Managed in this way, no extra heat is required, as that caused by the chemical action is sufficient to keep the fat liquid. If the bottles have stood, after the acid is added, until the contents are cooled, they should be warmed to about 200° F. by placing them in hot water before whirling. The machine should be frequently examined to make certain that there is no slipping of belts or frictional bearings which may cause too slow motion and result in an imperfect separation of fat.

Filling the Bottles. As soon as the bottles have been sufficiently whirled, they should be filled to near the top of the graduated part of the stem with hot water. If practicable, distilled or rain water should be used for the purpose. The bottles are most easily filled by means of the apparatus described on page 64. If only a few tests are to be made, the water can be added with the pipette or glass cylinder. The cover should then be replaced and the machine turned for about one minute, after which the fat may be measured.

Measuring the Fat. The fat when measured should be warm enough to flow readily, so that the line between the acid liquid and the column of fat will quickly assume a horizontal position when the bottle is removed from the machine. Any tempera-

ture between 110° F. and 150° F. will answer, but the higher temperature is to be preferred. The slight difference in the volume of fat due to this difference in temperature is not sufficient to materially affect results.

To measure the fat, take a bottle from its socket and holding it in a perpendicular position with the scale on a level with the eye, observe the divisions which mark the highest and the lowest limits of the fat. The difference between these gives the per cent of fat directly. The reading can easily be taken to half divisions or in the ordinary milk bottle to one-tenth per cent.

The line of division between the fat and the liquid beneath is nearly a straight line and no doubt need arise concerning the reading at this point; but the upper surface of the fat being concave, errors often occur by reading from the wrong place. The reading should be taken at the line where the surface of the fat meets the side of the tube and not from the surface of the fat in the centre of the tube nor from the bottom of the dark line caused by the refraction of the curved surface. For instance in fig. 5 the reading should be taken from a to b and not to c or d.

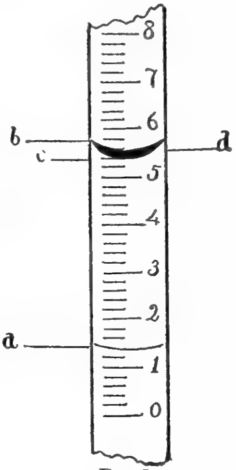


FIG. 5.

The reading may be made with less liability of error by measuring the length of the column of fat with a pair of dividers, one point of which is placed at the bottom and the other at the upper limit of the fat. The dividers are then removed and one point being placed at the zero mark of the scale on the bottle used, the other will be at the per cent of fat in the sample examined.

Sometimes bubbles of air collect at the upper surface of the column of fat and prevent a close reading; in such cases a few drops of strong alcohol (over 90 per cent) put into the tube on top of the column of fat will cause the bubbles to disappear and give a sharp line between the fat and alcohol for reading. Whenever alcohol is used for this purpose, the reading should be taken directly after the alcohol is added, as after it has stood for a time, the alcohol partially unites with the fat and increases its volume.

Whenever the fat is not quite clear, more satisfactory results may be obtained by allowing the bottles to stand until the fat has crystallized and then warming them by placing the bottle in hot water, before taking the reading.

TESTING MILK.

The original method of Dr. Babcock. The bottle usually employed for testing milk is shown in fig. 1, p. 62. It should be made of heavy glass and should hold, up to the neck, not less than 40 cubic centimeters. The neck is graduated to read in per cent of the amount of milk used. The graduation extends from 0 to 10 per cent, which is sufficient range for normal milk. The pipette for measuring milk should hold 17.6 cubic centimeters when filled to the mark. A pipette of this size will deliver 18 grams of milk of average specific gravity (1.032.) The milk is measured into the test bottle and the test made as described on pages 66-69.

The modified method. (Bartlett.) The method described above is the original method as announced by Dr. Babcock, and beginners and those who have had little experience are advised to follow that method. Those who are somewhat skilled in testing should use the modification of the method as given in Bulletin 31 of this Station. For convenience of reference the method is here reprinted.

After the milk is mixed by stirring or pouring from one vessel to another, the required amount, 17.6 cubic centimeters, is measured into the test bottle. It is then heated to about 70° F., if not already at that temperature, by setting the bottles in a tank of warm water. Twenty cubic centimeters of sulfuric acid (specific gravity 1.82 to 1.825) are added, and the bottle shaken by giving it a rotary motion, until the milk and acid are thoroughly mixed. The mixture is then allowed to stand not less than 5 minutes. No harm is done if it stands longer than 5 minutes and in fact, occasionally, some kinds of milk have to be given a little more time. After standing the necessary time, the bottle is given another gentle shake to mix in and dissolve any particles of curd that may have risen to the surface. Hot water is then added nearly to the uppermost mark, the bottle is put in the centrifugal machine and whirled for 5 minutes at

the rate of 1,000 to 1,200 revolutions per minute. A steam turbine machine is best for this purpose, but a hand or belt power machine can be used, if hot water is put in the pan to keep the fat melted. After the whirling is completed, the percentage of fat can be read in the usual manner.

For the modified test no change of apparatus need be made; the writer, however, prefers to have the base portion of the bottle graduated, so no acid measure is required and only one pouring of the acid is necessary. By having the bottle marked at the point A (fig. 6), at which mark it holds 37.5 cubic centimeters, one can, after the milk is measured in with the pipette, run the acid in until it is filled to this point. It was found impracticable to use a bottle like the one for cream described farther on, because of the larger amount of curd in milk than in cream and the small size of the neck of the milk bottle, necessitating more space for shaking, breaking up the curd and dissolving it in the acid.

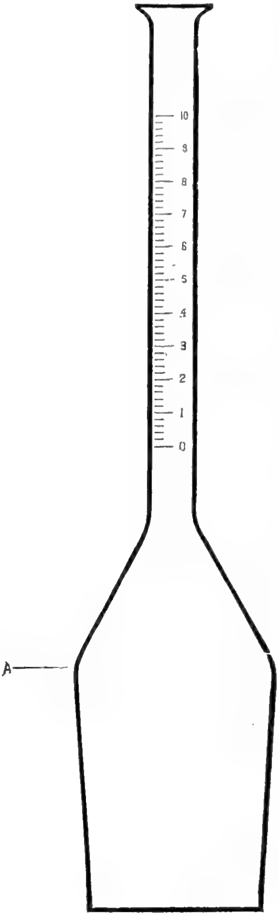


FIG. 6.

It would appear that the time required for the bottles to stand after the acid is mixed with the milk, would offset that gained by omitting the second whirling, which is made in the old method; but the writer has often found it necessary with many kinds of milk, especially with that from cows much advanced in the period of lactation, to allow the bottles to stand awhile, even when working the two whirling method, in order to get a clear separation of fat. However, every one who does much testing should have at least two sets of bottles, so there would be no loss of time by this process. When two sets of bottles are at hand, one set, charged with the milk and acid, can stand while the second set is being filled,

and the second set can stand while the first is being whirled. It is much better to make 12 tests at a time than to make a larger number. Twelve are about all one can easily read before the fat begins to cool and contract in volume.

Precautions. That good results and clear separations can be obtained by the previously described modifications, the writer and others connected with the College have fully demonstrated. It is necessary, however, that certain details be strictly observed to attain success, and to make those points more prominent they are repeated as precautions.

The acid must be of the proper strength; 1.82 specific gravity at 60° F., is more universally successful than a stronger acid, though 1.825 may be used in some cases. With very rich milk, 20 to 21 cubic centimeters of acid of 1.82 specific gravity works much better than a smaller quantity of stronger acid, probably because there is less water in rich milk to properly dilute the acid than in poor milk. Rather thin milk will give good results with acid of quite varying strength. If the acid is too strong, the fat will be blackened, or black particles will appear in the lower part of the fat column. If the acid is not strong enough, the fat will appear cloudy, and white particles of curd will collect at the lower part of the column so that an accurate reading cannot be made.

The milk should not be colder than 70° F., or warmer than 80° F. when the acid is added. If the milk is too cold, the curd will not all be dissolved in the time allowed, and the fat will appear cloudy with white particles in the lower part of the column which will interfere with the reading. If the milk is too warm, the action of the acid will be too violent, the fat will be burned, and the whole column appear blackened; or if only slightly burned, black particles will appear in the lower part of the column.

The acid and milk must be thoroughly mixed together and the mixture stand not less than 5 minutes before hot water is added; otherwise a clear separation will not be obtained. It is also best to shake the bottle again slightly, just before adding the hot water, to dissolve any particles of curd that have risen with the fat.

The bottles must be whirled and heat applied as directed, or the separation is liable to be incomplete. Sometimes a cloudy fat can be cleared by heat and longer whirling.

Nearly all of the above precautions must be observed to obtain correct results by the method as originally proposed.

TESTING SKIMMED MILK, BUTTER MILK AND WHEY.

Skimmed milk, butter milk and all similar products usually contain small amounts of fat, much less than one per cent. They can be tested with the ordinary milk bottle in precisely the same manner as whole milk, with sufficient accuracy for all practical purposes. If greater accuracy is desired, however, a special test bottle which holds twice as much as the ordinary bottle can be used. In such a bottle *twice* the usual amount of milk and acid are taken and the column of fat, being double in length, can be read with greater accuracy. Each division on the scale of this bottle corresponds to 0.1 per cent. Another bottle known as the Ohlsson or "B & W" test bottle has recently been devised for testing very small percentages of fat. This bottle has two necks, the larger of which is to admit the milk to the bottle, and the smaller is a very fine tube in which the fat is measured. As claimed by the inventor, one can easily read 0.01 per cent on the tube, if it were desirable to do so. Inasmuch, however, as it is impossible to estimate to much less than 0.1 per cent by the Babcock test it is hardly worth while to read so fine as .01 per cent.

By exercising very great care the writer has been able to obtain results with this bottle that compare very well with the gravimetric method down to .05 per cent. In order to do this the following precautions must be observed: The bottle must be perfectly clean, otherwise small particles of fat will adhere to the walls and not be removed by the centrifugal force. Twenty cubic centimeters of sulfuric acid, specific gravity 1.82, must be used, and the milk warmed to about 70° F. before the acid is added. The machine must run 5 minutes at about 1,000 revolutions per minute, and the bottles be kept at a uniform temperature, either by steam or hot water, during the time. The reading of the scale should be taken immediately after the whirling

is completed and before the neck of the bottle gets cold, otherwise some of the fat will adhere to its walls and be lost.

This bottle is quite delicate in structure and therefore easily broken, and should only be used by persons who have had considerable experience in handling glassware.

TESTING CREAM.

Cream is a little more difficult to accurately test than milk. The chief reason for this is that it contains a much higher percentage of butter fat, and an error in sampling or measuring out the portion for the test makes a greater difference in the result. It also has a greater consistency than milk and is more liable to froth when given the mixing necessary to make it homogeneous. Cream that is frothing cannot be accurately measured in a pipette, because the air bubbles occupy space that should be filled with cream.

The Original Method of Testing Cream. Sweet cream, such as is ordinarily obtained from the cold deep setting process of raising, can be tested without difficulty by practically the same method as that which is given for milk on pages 66-69, the only modifications necessary being in the bottles and pipettes used.

Test Bottles. Two styles of test bottles adapted to this purpose are in general use. One, a bottle designed at this Station for testing both cream and milk, and described in Bulletin No. 3, Second Series (fig. 2, page 62) has a long, small neck with a bulb and a scale reading from 0 to 25 per cent. The other is the so-called Connecticut Station bottle, described in Bulletin 117 of that Station. This bottle is similar to a milk bottle except that it has a wide neck with a scale reading from 0 to 30 per cent.

A new bottle, which the writer prefers for testing cream, was described in Bulletin 31 of this Station. While this bottle can be used in the same way as the other cream bottles, it is particularly designed for use in the modified method. The bottle and a way to use it are described on pages 78-79.

Pipettes. The pipette used for cream is practically the same as the one used for milk, except that it is graduated to hold 18 instead of 17.6 cubic centimeters. A cubic centimeter pipette is also very convenient in handling thick cream.

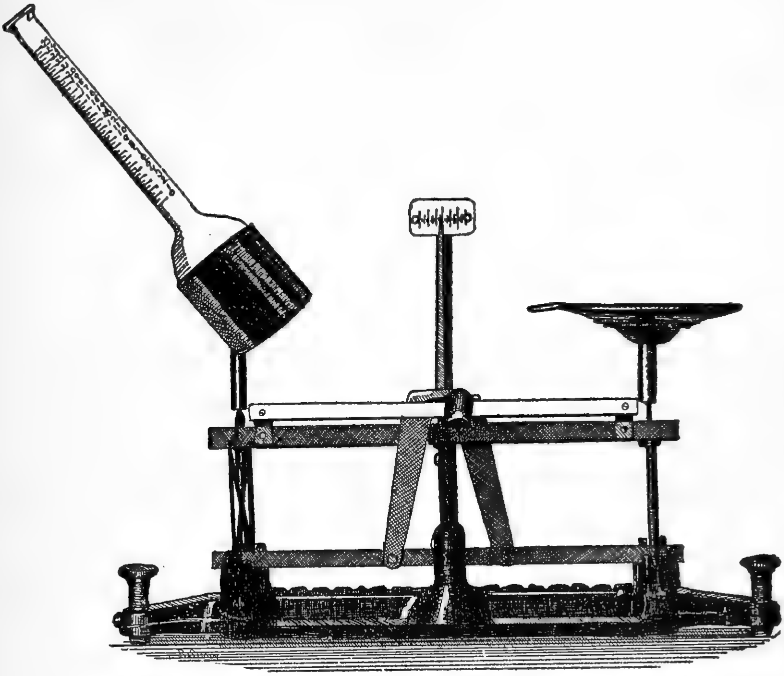


FIG. 7.

Scale for Weighing. As has already been stated, sweet cream that is not frothing and does not contain over 25 per cent of butter fat can be accurately measured with a pipette. If, however, the cream is sour and thick, as will sometimes happen, it cannot be tested without considerable trouble. It can be gotten into condition by means of caustic soda and heat, as recommended on page 66, but if it is simply broken up by shaking, it will contain many air bubbles and cannot be measured correctly. Thick separator cream is seldom in condition to measure with any degree of accuracy, and if it is very rich, an error as great as 10 to 15 per cent of the total fat may be made.

The only accurate method to pursue in such cases is to weigh the cream, and this can be very easily done by any one who has skill enough to make the test. The balance or scale recommended is shown in the above cut, and was designed by the Springer Torsion Balance Company especially for this purpose from suggestions made by the writer. The peculiar feature of the Torsion Balance is, that it has no knife edges, the

beam and pan being supported on flat spring steel wires. Knife edges become dulled by wear or corrosion, consequently a knife edge balance, in constant use, loses its sensitiveness quite rapidly.

The manufacturers of the Torsion Balance claim that their balances do not become less delicate by use, but retain their original sensitiveness until worn out. This claim seems to be well supported, not only from the nature of their construction but by practical tests. For this reason a scale of this construction was selected, and the one shown in the cut was used successfully by the dairy students the past winter. It is about 10 inches long and 7 inches high, and although delicate enough to weigh accurately to .05 gram, is quite strong and durable. The left hand pan is provided with a support for the bottle, and the right hand pan is used for a counterpoise and weights. A side beam on which slides a light counterpoise to be used in balancing the bottles greatly facilitates this part of the process. A heavier counterpoise, equal in weight to the lightest bottle one uses, can be kept constantly on the right hand pan. This counterpoise can be made of small shot or a piece of any metal of convenient size. Above the middle of the beam is a graduated scale to which points an indicator that shows very plainly when the balance is in equilibrium. Two brass weights are provided, one weighing 9 grams and one 18 grams. It will be noticed that the bottle sets in an oblique position so that the top of the neck is not directly over the pan, thereby decreasing very much the liability of dropping cream on the pan or bottle when running it in.

The scale if properly used will be very durable. Of course, it is, necessarily, a somewhat delicate piece of apparatus and cannot be handled as roughly as a grocer's scale without injury; but with reasonable care and protection from moisture when not in use, it will last many years. There is a device at the bottom of the scale for locking the pans to prevent them from vibrating when not in use. It is very essential for the good of the balance that these be locked and not allowed to rest on the bearings when set aside.

Method of using the Scale or Balance. First place the scale on a firm, level shelf or table that does not shake or jar, with the beam to the front, and the pan with the support for the bottle on

the left. Slide the counterpoise on the beam to the extreme left and put the counterpoise weight, which is about equal to the weight of the lightest bottle used, on the right hand pan and the bottle to be weighed on the left. Unlock the pans by turning up the lever on the left hand end at the bottom to a perpendicular position. Now slide the counterpoise on the beam slowly to the right until the scale balances, as shown by the indicator above vibrating equally each side of the middle division of the lines to which it points. After the bottle is counterpoised, put the 18 gram weight on the right pan, fill the pipette with the cream to be tested a little above the 18 cubic centimeter mark, and hold it so the nozzle just clears the neck of the bottle at the opening, and allow the cream to run in. When the pipette is nearly empty, the flow is checked by pressing the finger over the opening at the top until the cream drops slowly. Now watch the scale closely, and when the last drop makes the indicator vibrate, or shows that the cream balances the weight, the pipette is removed. If by accident too much is run in, a little can be sucked up with the pipette or turned from the bottle, and then enough dropped in to balance the weight.

Another convenient method of putting in the cream is to balance the bottle, then remove it from the scale pan and measure in 18 cubic centimeters of the cream, return the bottle to the pan and add enough more cream, drop by drop, to balance the 18 gram weight.

After a little practice one can do this very skillfully, and nearly as rapidly as he can measure. When cream contains more than 25 per cent of fat, use the 9 gram weight instead of the 18, and multiply the result by 2. When 9 grams are taken, 9 cubic centimeters of water must be added and the usual amount of acid. If, by chance, any cream is dropped on the pan or outside of the bottle, it must be wiped off before the weight is taken. No two bottles weigh the same and each must be counterpoised before cream is put in it.

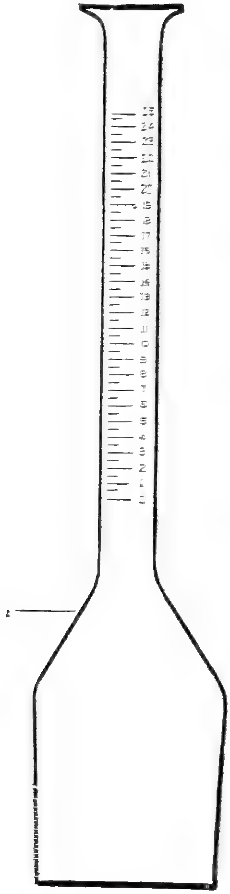


FIG. 8.

The modified method of cream testing.

The test bottle. (Fig. 8.) This is similar to the regular milk bottle, except that the base portion is made of such size as to avoid using an acid measure. The base is made to hold 38 to 40 cubic centimeters up to the neck and after the cream is measured in, the required amount of acid can be added by filling the bottle nearly to the neck or to the point A shown in the cut. The neck portion is large enough to carry 25 per cent of fat and is graduated to one-half of one per cent and can be easily read to one-quarter of one per cent. Each per cent is numbered. Although one cannot read so closely with this as with the bulb neck bottle shown on page 62, fig. 2, which was designed to test both milk and cream, one can read fine enough for all practical purposes. On account of the neck being larger and shorter, this bottle is more easily cleaned than either of the older forms; it is less liable to breakage, and by using the method given for milk on pages 70-72 a test can be made more rapidly. Twenty-five per cent was fixed upon as the capacity of the neck, for the reason that a much higher percentage necessitates an increase in diameter, which impairs the accuracy in reading and again, nearly all cream shipped to the creameries is raised by the cold deep setting process and seldom contains more than 20 per cent of fat. If one wishes to test separator cream that is very rich, 9 cubic centimeters or 9 grams of the cream can be taken instead of 18, 9 cubic centimeters of water added and the usual amount of acid. The reading obtained in that case, of course, should be multiplied by 2 to give the correct per cent.

Method of using Bottle. Measure 18 cubic centimeters or weigh 18 grams of the thoroughly mixed cream, carrying not more than 25 per cent of fat, into the bottle. Heat it to

about 70° F., if not already at that temperature, then fill the bottle up nearly to the base of the neck (point A, fig. 8) with sulfuric acid, specific gravity 1.82. The acid can be handled in a sharp-nosed pitcher or run in from a syphon affixed to a carboy. Mix the acid and cream together thoroughly, which is best done by grasping the neck with the hand, pressing the thumb tightly over the opening and then giving the bottle a rotary motion, holding it upright all the time. The confined air prevents the curd from coming up and sticking to the sides of the neck. The mixing is just as easily done in this as in the old style bottle. The remainder of the process is conducted exactly the same as in testing milk, described on pages 70-72.

If the above directions are followed, a perfectly clear separation will be obtained, with a considerable saving of time over the old method, as only one pouring of the acid and one whirling of the machine are made. The precautions given on page 72 under "Testing Milk" apply also to cream.

APPLICATION OF THE TEST.

The test is applicable to all problems involving a knowledge of the content of butter fat in dairy products. In the pages which follow, the most important uses of the method are pointed out.

THE TEST APPLIED TO THE FARM.

The Babcock test may well be said to be invaluable to the farmer, as it gives him a simple and accurate method of testing his cows with much less labor than was required by the old method, with the churn. By its use he can weed out his poor and unprofitable animals, which are eating up the profits of the good cows. Every farmer keeping five or more cows should have access to a tester.

How to Test a Cow. Milk the cow thoroughly dry at the usual hour. A pail sufficiently large to hold the entire amount of milk given should be used. After the milking is completed, mix the milk thoroughly by turning it two or three times from one pail to another, then immediately take out the sample to be tested. Testing a single milking, however, shows only whether the cow is giving very rich or very poor milk, and does not furnish an accurate knowledge of the quality of her product, for

the reason that the percentage of fat is subject to considerable variation from day to day.

To get a reliable result, at least 6 consecutive milkings should be tested. This is most easily done by making a composite sample as follows. After the milk is drawn from the udder, turn it into a deep and narrow can or pail, then lower the sampling tube, described on page 65 and take out one tube full. Have at hand a half pint fruit jar labeled with the cow's name or number, and run the contents of the tube into it, closing the jar tightly to prevent evaporation. Proceed in the same manner each time for 6 consecutive milkings. Care must be used to lower the sampling tube with the lower end open to the bottom of the pail, so as to secure a column of milk that will represent the whole. By this method a proportional part of each milking is taken and a very accurate sample obtained.* A small piece of bichromate of potash, about the size of a pea bean, should be put in the jar and dissolved in the milk, to prevent its souring in warm weather. After the last tube full has been put in the jar and the whole thoroughly mixed, the composite sample is complete and can be tested. The percentage of fat found will be a fair representation of the quality of milk the cow is giving.

If one wishes to learn the true value of a cow as a butter producer, it is necessary to know the quantity of butter fat given. This can be estimated approximately by testing the cow every two or three months and keeping a record of the number of pounds of milk she gives. To get an accurate result, the milk should be tested each month, for as the period of lactation advances, the quantity of milk *decreases*, while the percentage of fat *increases*. With a fat test of the composite sample and a record of the number of pounds of milk given for each month, the total fat yield is very simply calculated by multiplying the per cent of fat found by the number of pounds of milk for that month. The yield for the whole year will be the sum of these monthly products. If several cows are being tested, a sample jar, properly labeled, should be supplied for each one.

A very convenient form of keeping records is shown on page 82, and explains itself. Fools-cap paper can be ruled off to

* In the absence of a sampling tube the sample can be obtained by pouring the freshly drawn milk from one vessel to another three or four times and quickly dipping up a small cup or ladle full, and pouring this into the jar.

answer the purpose at very little expense. One space is allowed for each day's milk, the weight of the morning's milk being put in the upper part of the space and the weight of the night's milk in the lower part.

The Vermont Experiment Station has made a special study of the question at what times in the period of lactation a cow should be tested to give a fairly accurate idea of the whole year's yield, by making one or two tests. The results obtained indicate that the first test for spring cows should be made about 6 weeks after calving, summer cows, 8 weeks after calving, and fall cows 8 to 10 weeks after calving. The second test should be made about 6 to 7 months after calving. Composite samples of 4 days' milk should be used for these tests. To find the quantity given, weigh the milk for 4 days in the middle of each month during the period of lactation. These weights will give a very close average for the months in which they are taken. The average of all the weights obtained multiplied by the number of months the cow is giving milk will give the total yield. This product multiplied by the average per cent of fat found will give the total yield of butter fat.

APPLICATION OF THE TEST TO SEPARATOR BUTTER FACTORIES.

Although it is quite generally admitted that the quality as well as quantity of milk delivered, should be considered in making dividends in factories where milk is pooled, many who recognize the justice of the relative value plan hesitate to adopt it, on account of the labor and expense involved in making daily tests from each patron's milk. The best plan yet proposed for reducing the expense of the necessary tests is that of the composite sample first described by Professor Patrick.*

* Bulletin 9, Iowa Agricultural Experiment Station, 1890.

MILK RECORD

FOR THE MONTH OF ...., 1898.

Day.	Cow's Number. 1	2	3	4	5	6	7	8	9	10
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1										
2										
3										
4										
5										
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25										
26										
27										
28										
29										
30										
31										
Total										
Fat per cent										
Total fat										

In buying milk on this plan it is necessary that care should be taken to get correct samples. A pint or quart fruit jar should be provided for each patron and labeled with his name or number, if one has been assigned him. Into this put a small quantity, as much as one can hold on one-half inch of a pen knife blade, of the preservative, powered bichromate of potash. A measured portion of every lot of milk furnished by a patron should be taken and put in the jar bearing his number. The milk should first be thoroughly mixed by stirring or pouring from one can to another, and the sample taken immediately The sampling tube described on page 65 is the best instrument for this purpose and should always be used.

Whenever a fresh portion of milk is placed in the jar, it should be mixed with milk previously added by giving the jar a rotary motion. The jars should always be closed tightly to avoid evaporation and kept in a cool place. At the end of two weeks, or as often as one desires, the composite samples are tested. The percentages of butter fat found represent the average composition of each patron's milk for that time, and the product obtained by multiplying these percentages by the respective number of pounds of milk furnished will give the number of pounds of butter fat furnished.

THE TEST APPLIED TO GATHERED CREAM BUTTER FACTORIES.

When the Babcock test was first introduced, the butter factories of this State were nearly all buying cream by the inch and paying a uniform price, regardless of its quality. The defects and injustice of that system were, even then, realized at some factories, and those in charge did not hesitate to say that a change must be made or the business discontinued. For this reason the Station recommended the use of the Babcock test, believing that it offered a practicable and accurate method of determining the actual butter value of cream. Nearly all of the creameries in the State have adopted this system and are paying for cream on the basis of the butter fat it contains.

Causes which affect the quality of cream. Cream for butter making is only valuable in proportion to the amount of butter fat it contains, and there are many factors in raising cream by the gravity process which have a decided influence on its

fat content. Much of the dissatisfaction among the patrons of creameries comes from a lack of understanding of the conditions that affect the quality of cream.

The temperature at which the milk is set has a very marked effect on the quality of the cream produced. Cream from the same herd of cows will vary in butter fat as the temperature of the water in which the cans are submerged changes. If the milk is kept at a temperature of about 35° F., instead of 45° F., the cream will often drop 4 or 5 per cent in butter fat. This explains the fact that cream frequently tests lower in very cold weather than in warm weather. The volume increases correspondingly, so there is no loss of butter fat. If the water in the creamer is allowed to become warmer than 45° F. the cream becomes proportionately richer. Keeping the milk at a temperature of 65° F. or 70° F. will cause an increase of 10 or 15 per cent of butter fat in the cream, while the volume of the cream decreases. This latter temperature is objectionable because the separation is not so complete and more fat is left in the skimmed milk than when the lower temperature is used.

To make cream at all uniform in composition it is necessary to use the greatest care in handling and setting the milk. The water must be kept at an even temperature, the milk set immediately after being drawn, and the intervening time between setting and skimming the milk be the same. Cream raised by setting the milk 12 hours is not as rich as cream obtained from milk set 24 hours.

It seems hardly necessary to mention that the amount of skimmed milk drawn off with the cream affects its quality. It should be apparent to every one that increasing its bulk with skimmed milk decreases proportionately its per cent of butter fat. Only the best methods of skimming should be employed. The old method of dipping the cream from the top of the milk is wasteful and should not be practiced. The best method is to draw the skimmed milk off by a faucet at the bottom of the can, and about one inch of skimmed milk should always be left under the cream, as drawing closer than that endangers loss of fat.

The above facts will account for most of the variations in the fat content of cream and show how necessary it is to sample each

lot of cream collected in order that the composite sample shall fairly represent the whole. Little dependence can be put on the test of a single lot of cream as representing the percentage of fat contained in the cream furnished for a month or any given time, and patrons have a right to demand that a sample of each lot of cream collected shall be taken and tested by itself or made a part of a composite sample.

When the test was first introduced, an attempt was made to continue the inch system of measuring the cream, but that involved too much work and when the space pail was brought out by an enterprising dealer, it was quite generally adopted. This pail has a scale so made that the product obtained by multiplying the number of spaces of cream by the percentage of fat it contains, gives approximately the number of pounds of butter containing 85 per cent of butter fat. This space pail furnished a method which was a great improvement over the inch system and has served a valuable purpose in the creamery business.

At one time there were at least three systems of buying and paying for cream by the test in use in this State and it was not surprising that there was considerable confusion and distrust among farmers. Recognizing the necessity of uniformity in this work, the Station issued a bulletin in 1894 advocating weighing instead of measuring cream. The method of weighing is believed to be simpler, more accurate and just as convenient as measuring.

Sampling the Cream. If it were practicable, it would be much better to have each patron's cream brought to the factory by itself; then the one who operates the test could see that a correct sample is taken and the butter maker could inspect its quality for butter making. As most of the creameries at the present time are not able to adopt this plan, a method is here given by which the collector takes the sample.

The man who does this work should be reliable and thoroughly instructed in taking the sample before he starts out. Too much care cannot be used in this part of the work. Correct sampling is a matter of dollars and cents to the farmer and success or failure to the creamery, for no enterprise can expect to succeed for any length of time, unless justice is done to all parties concerned. It is for this reason that the employment

of cheap labor for collecting, and letting the cream routes to the lowest bidder, regardless of his qualifications, are to be condemned. The law requires the operator of the test to understand his part of the work. It is equally important that the collector should have a thorough knowledge of sampling. If the sample is taken carefully with the tube, as directed on page 87, it will be done correctly; but if the collector is in a hurry and carelessly lets the tube drop down closed or quickly, so that it fills from the bottom, or takes his sample from but one can when there are several, the sample may be far from correct. It may seem that correct sampling takes a good deal of time, but as a matter of fact it takes but little more time than it does to do the work improperly. As success or failure of the business may depend upon the results obtained, it is imperative that the work be properly done. The patrons of a creamery are much given to decrying the test when the results do not suit them, but it is safe to say that in nearly every case the discrepancies are due to other causes than errors in testing, and very often to sampling, which is within the control of the patron. Let every patron who is not satisfied get a tester himself or in combination with his neighbors, and sample and test his own cream. It would take but little time and perhaps be dollars in his pocket.

Collector's Apparatus for Sampling and Weighing Cream. Pail for Weighing. For this purpose a light pail not more than 9 or 10 inches in diameter and 18 to 20 inches deep, having a strong bail, a lip or nose on the top and handle near the bottom to assist in emptying, is recommended. It should be made of light material and strengthened at the top by a hoop, to avoid denting when being emptied. Such a pail holds 50 pounds of cream, which is as much as a collector cares to handle at once.

Scales for Weighing. There are several spring scales on the market that doubtless are good for this purpose, but the best we have seen is a Chatillon dial spring scale with an adjustable tare, that will weigh up to 60 pounds by tenths. These scales are very convenient and are sufficiently accurate with light weights for this work; but are reported by some who have used them, not to be very accurate when loaded to near their full capacity. Of course all spring scales deteriorate quite rapidly

in constant use. A more durable, accurate, and nearly as convenient scale is the so-called " market scale," which is provided with an iron crane, a single beam, brass sliding counterpoise and brass weights. This scale can be attached to an upright post on the cream wagon in the same manner that it is attached to the market wagon. The weighing pan with which they are equipped, can be replaced by the collector's pail properly counterpoised. These scales range in capacity from 50 to 125 pounds; one to carry 100 pounds would answer the purpose of most creameries. It is much more convenient, in making calculations, to have the scale weigh to tenths of a pound than to ounces.

Bottle for Carrying the Sample. A two-ounce, wide mouthed bottle, made of strong glass or preferably, white metal, and provided with a cork stopper is used. A case should be provided for these bottles with pockets to prevent them from rattling around, and a closely fitting cover to protect them from cold in winter. Each bottle should be marked with the number of the patron for whom it is to be used.

Preservative. Bichromate of potash is recommended for this purpose. After the sampling bottles are thoroughly cleaned with hot water and washing soda, a small amount, just enough to give the cream a light yellow color, of the finely powdered bichromate of potash should be put in each bottle before starting out to collect cream. If the cream is sweet when sampled and well shaken up after being put in the bottle, so as to dissolve and thoroughly mix the powder, it will keep sweet four weeks if kept in a cool place. Too much bichromate interferes with the test. Formalin is now being quite generally used as a preservative of milk and will possibly be found more convenient than bichromate, but the writer has not yet had sufficient experience with the material to warrant recommending it.

Manipulation. After the cream has been turned into the weighing pail, the sample is taken by letting the open sampling tube, described on page 65, slowly to the bottom of the pail. The opening is then closed, the tube taken out, allowed to drain a moment and the contents run into the bottle marked with the patron's number. In order to obtain a fair sample, the tube must be let down slowly with the end open so it will fill as it

goes down. If the tube is let down quickly, or with the end closed, and then allowed to fill from the bottom of the pail, it is possible to get a sample much less rich in fat than the top would yield. If there is more than one pail of cream, a portion should be taken from each lot weighed out. If a tube full from every pailful more than fills the sample bottle, then all the portions drawn should be mixed in a dish large enough to hold them, and the bottle filled from the mixture. In any case, enough should be taken to fill the sample bottle to prevent churning on the road.

Cream that is sour should not be sampled, as it is impossible for a collector to get a fair sample of it in any reasonable length of time. If it has become thick, it cannot be easily mixed by the collector so it will be uniform, and cannot be sampled with the tube. Creamery managers should insist that patrons keep their cream sweet until it is taken by the collector. This is essential not only to correct sampling, but to make a good quality of butter.

Composite Sample. The composite sample is made up from the small samples taken by the collector and is the one from which the portion is taken for the test. Pint fruit jars are good receptacles in which to put these samples, and each one should be numbered with the patron's number, the same as the small bottles used by the collector.

The small samples are taken every time the cream is collected according to the directions previously given, and as soon as they arrive at the factory they are emptied into the fruit jars having corresponding numbers. The jar should be closed tightly to prevent evaporation. These accumulated small samples constitute the composite sample, and the per cent of butter fat found in this sample, will be the average per cent in all the cream furnished by the patron having that number for the period. A test can be made once in four weeks or oftener.

Valuing Cream. When cream is bought by weight, according to the plan previously outlined, valuing it or fixing the price of each patron's product is very easily accomplished. Each lot collected is weighed and sampled. The weight is recorded and the sample goes to make up the composite sample previously described. At the end of the month the sum of the weights found

credited to any one patron shows the number of pounds of cream he has furnished, and the per cent of fat found in his composite sample shows the average per cent of fat in his cream for that month. Then the product of the number of pounds of cream furnished multiplied by the per cent of fat it contains will be the number of pounds of butter fat he has supplied. The money value of the cream will be the product of the number of pounds of butter fat multiplied by the price per pound. For example, suppose A furnishes 350 pounds of cream for the month. His composite sample tests 18 per cent fat and the price paid for fat is 23 cents. Then A will receive $350 \times .18 \times .23 = \$14.49$ for his month's cream.

Pay for fat and not butter. From the preceding calculations we see that when a price is fixed for butter fat, finding the value of a patron's cream is a very simple process, easily understood, and for this reason recommends itself to every one. It is much simpler than the common practice of calculating the fat over into butter, for that has to be done for every patron in the creamery, while the price for butter fat is calculated but once for all the patrons for any one month and can be used as a common factor in calculating the value of each man's cream.

How to fix the price of butter fat. In a co-operative creamery this is as simple a matter, when the cream is bought by the test, as it is to fix the price of butter. The manager learns from his books the gross income from sales of butter and cream for the month and deducts therefrom the expense of the factory to find the amount of net profits to divide among the patrons. He also has a record of the number of pounds of butter fat received. To find the price per pound to be paid patrons, he simply divides the number of dollars to be paid by the number of pounds of butter fat furnished. For example, suppose the factory has $330 to divide among its patrons for one month's dividends for which it has received 1,500 pounds of butter fat, then $\$330.00 \div 1{,}500 = \$0.22$, the price of butter fat for that month.

It sometimes becomes necessary, especially when cream is bought from the patrons and the creamery is non co-operative, to value it on a basis of the market price of commercial butter. Hardly two lots of butter will contain the same amount of fat, so a fair average percentage must be taken. A really good butter

to stand up well in all kinds of weather, should contain about 85 per cent of fat, and that is the factor usually made use of. Therefore we assume that a pound of commercial butter contains .85 of a pound of fat, consequently to find the price of butter fat the market price of butter is divided by .85. For example, if butter is 20 cents per pound, then .20÷.85=23.5 cents, the price per pound of fat.

The system of apportioning dividends to patrons just described, namely, weighing the cream and fixing a price for butter fat, seems to be the simplest and best yet suggested. It is the method which is in general use in milk gathering factories in the West and in the gathered cream creameries of Massachusetts and Connecticut, and there seems to be no good reason why the creameries of Maine should not universally adopt it. The sooner this is done the sooner will the patrons understand the methods of the creameries and gain confidence in their management, but as long as several methods are in use, nothing but confusion and distrust can be expected. A few creameries in the State have already adopted and are using this method satisfactorily.

TESTING BUTTER.

Butter is the most difficult of all dairy products to test accurately for fat. The writer, however, has had fairly good success by the following method. A bottle with a separable neck, similar to the cream bottle No. 3, described in Bulletin 3 of this Station, is used. The neck is a tube enlarged in the middle like a pipette and having a total length of about 10 inches. Above and below the enlarged portion, the tube is about the size of the neck of the milk bottle and graduated the same, the scale reading on the lower part being 0 to 10 per cent and on the upper 80 to 90 per cent of fat.

Method of Making the Test. Put the base portion of the bottle on the scale and counterpoise it as directed in weighing cream. About a half pound of the butter to be tested is put in a bottle or small fruit jar and placed in water heated to 110° to 120° F. until the butter is all melted. It is then taken and shaken vigorously for a minute and the 18 cubic centimeter pipette filled immediately, before the salt and water have a chance to

settle to the bottom of the jar. The contents of the pipette is then run into the bottle, the jar shaken again and more butter taken up and run drop by drop into the bottle until the scale turns. Remove the bottle from the scale and add 9 cubic centimeters of hot water and 10 cubic centimeters of sulfuric acid, (1.82 specific gravity), mix thoroughly, place in the centrifugal machine and whirl a few minutes at usual rate. Then take the bottle from the machine, connect the neck by a piece of rubber tubing and stand the whole in a tank of water heated to 110° to 120° F., sufficiently deep to allow the water to come up to near the 90 per cent mark. Now fill the bottle to near the 87 per cent mark with hot water and let it stand several minutes before reading. The reading is taken the same as on the milk or cream bottles.

TESTING CHEESE.

How to take the Sample. Where the cheese can be cut, a narrow wedge reaching from the edge to the centre of the cheese will more nearly represent the average composition of the cheese than any other sample. This may be chopped quite fine, with care to avoid the evaporation of water, and the portion for analysis taken from the mixed mass.

When the sample is taken with a cheese tryer, a plug taken perpendicular to the surface, one-third of the distance from the edge to the centre of the cheese, should more nearly represent the average composition than any other. The plug should either reach entirely through or only half through the cheese. For inspection purposes the rind may be rejected, but for investigations where the absolute quantity of fat in the cheese is required, the rind should be included in the sample. It is well when admissible, to take two or three plugs on different sides of the cheese, and after splitting them lengthwise with a sharp knife take portions of each for the test.

Making the Test. For the estimation of fat in cheese, 6 grams should be carefully weighed out in a cream test bottle. Twelve cubic centimeters of hot water is then added, and the bottle shaken at intervals, keeping it warm, until the cheese has become softened, and converted into a creamy emulsion. This may be greatly facilitated by the addition of a few drops of

strong ammonia to the contents of the bottle. After the contents of the bottle have become cold, the usual amount of acid should be added and the bottles shaken until the lumps of cheese have entirely dissolved. The bottles are then placed in the machine and whirled, the test being completed in the same manner as with milk. To obtain the per cent of fat, the reading should be multiplied by three.

TESTING CONDENSED MILK.

The estimation of fat in condensed milk is accomplished in exactly the same way as with cream. As a rule, condensed milks are so thick that it is impracticable to measure the test sample directly with a pipette. This difficulty may be overcome by carefully diluting the milk with a known volume of water, making the analysis of this and correcting the result for the quantity of water added. The best method is to weigh the sample into a test bottle, taking about 9 grams, and after adding about 9 cubic centimeters of water completing the test in the same manner as with milk, the per cent of fat being obtained by multiplying the reading by two. The results are satisfactory.

THE LACTOMETER AND FAT TEST FOR DETECTION OF ADULTERATED MILK.

The most common adulterations are the removing of cream and the addition of water. By determining the fat and the solids not fat, either or both of these adulterations are easily detected.

In many states legal standards for fat and solids not fat have been established in order to protect the public against fraud. In some states the required standard is 3 per cent fat, in others 3.5 per cent and solids not fat about 9 per cent. Milk from a good sized herd varies but little from day to day. Milk from a single cow may vary quite widely in fat, but from a herd will seldom vary more than 0.2 or 0.3 per cent, and solids not fat even less.

It is rather difficult to fix any standard, so great is the variation in different animals, but it is very rare that the mixed milk from a large herd at any season of the year will fall below

12 per cent total solids, unless it has been diluted. Milk containing less than 9 per cent solids not fat is suspicious, and a sample containing much less than 8.5 is probably watered. When a standard is adopted, the only course to pursue is to consider all milk falling below this standard adulterated. If the milk is not up to the standard, it matters not whether it is from poor cows or is diluted after milking, the results are the same.

It is necessary, therefore, in order to detect adulteration to determine both the fat and the other solids. For the determination of the former, one has recourse to the Babcock test, and the solids not fat can be quite readily and accurately estimated (from the specific gravity and per cent of fat) by means of a formula. The specific gravity of whole milk at 60° F. varies from 1.030 to 1.034. This means that when a certain volume of distilled water at 60° F. weighs just 1,000 pounds the same volume of milk will weigh 1,030 to 1,034 pounds.

The solids not fat, namely, the casein, albumin, milk sugar and mineral matter, are constituents of milk that are heavier than water and therefore cause its greater weight. On the other hand the fat is lighter, consequently the abstraction of fat increases the specific gravity, and the addition of water decreases the specific gravity, so one can readily tell by these two tests whether the milk has been skimmed or diluted with water. For example, suppose a sample of whole milk contains 4.2 per cent fat, and has a specific gravity of 1.032. If this milk were diluted one-half with water, it would contain 2.1 per cent fat and have a specific gravity of about 1.016, while if it were partially skimmed to contain about 2.1 per cent fat its specific gravity would be increased to about 1.0345.

The Lactometer. The lactometer is an instrument for taking specific gravity and is sufficiently accurate for practical purposes. There are several kinds in use at the present time, all of which are made on the same general principle, viz.: A narrow stem attached to an elongated bulb, weighted at the bottom so that it will maintain an upright position when floating in the milk, with the stem, which is graduated, partially submerged. The mark on the stem to which it sinks shows the specific gravity. The instrument for which the formula and

table are constructed is the Quevenne lactometer. The scale on the stem expresses in thousandths the weight of the liquid in which it is placed as compared with water. The graduations are usually from 15 to 40. To illustrate, milk having a specific gravity of 1.032 would give a reading of 32 on the lactometer and one having a specific gravity of 1.025 would give a reading of 25.

Method of Making the Test. To take the specific gravity with the lactometer it is necessary (1) that milk be free from air bubbles, and in order to insure this it should stand at least one-half hour after being drawn; (2) that it should be thoroughly mixed by pouring from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks read. The lactometer can easily be read to half spaces when it is necessary to be quite accurate. In case it is not convenient to bring the milk to the temperature of 60° F., a correction may be made, where the variation is not more than 10°, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60, and substracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected, would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent of fat, and taking the lactometer reading, the per cent of solids not fat may be found by the table given on page 95. Find the per cent of fat in one of the side vertical columns, and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent of fat, and the figures found at this point will be the per cent of solids not fat in milk.

For example, suppose the per cent of fat is 4.5 and the lactometer reading is 32, then the per cent of solids not fat will be 8.92. Suppose the lactometer reads 33 instead of 32 in the above example, then the per cent of solids not fat would be 9.17. The per cent of solids not fat added to the per cent of fat gives total solids.

Per cent of fat.	Quevenne Lactometer Readings at 60° F.											Per cent of fat.
	26	27	28	29	30	31	32	33	34	35	36	
1.0	6.70	6.95	7.20	7.45	7.70	7.95	8.20	8.45	8.70	8.95	9.20	1.0
1.1	6.72	6.97	7.22	7.47	7.72	7.97	8.22	8.47	8.72	8.97	9.22	1.1
1.2	6.74	6.99	7.24	7.49	7.74	7.99	8.24	8.49	8.74	8.99	9.24	1.2
1.3	6.76	7.01	7.26	7.51	7.76	8.01	8.26	8.51	8.76	9.01	9.26	1.3
1.4	6.78	7.03	7.28	7.53	7.78	8.03	8.28	8.53	8.78	9.03	9.28	1.4
1.5	6.80	7.05	7.30	7.55	7.80	8.05	8.30	8.55	8.80	9.05	9.30	1.5
1.6	6.82	7.07	7.32	7.57	7.82	8.07	8.32	8.57	8.82	9.07	9.32	1.6
1.7	6.84	7.09	7.34	7.59	7.84	8.09	8.34	8.59	8.84	9.09	9.34	1.7
1.8	6.86	7.11	7.36	7.61	7.86	8.11	8.36	8.61	8.86	9.11	9.37	1.8
1.9	6.88	7.13	7.38	7.63	7.88	8.13	8.38	8.63	8.88	9.13	9.39	1.9
2.0	6.90	7.15	7.40	7.65	7.90	8.15	8.40	8.66	8.91	9.15	9.41	2.0
2.1	6.92	7.17	7.42	7.67	7.92	8.17	8.42	8.68	8.93	9.18	9.43	2.1
2.2	6.94	7.19	7.44	7.69	7.94	8.19	8.44	8.70	8.95	9.20	9.45	2.2
2.3	6.96	7.21	7.46	7.71	7.96	8.21	8.46	8.72	8.97	9.22	9.47	2.3
2.4	6.98	7.23	7.48	7.73	7.98	8.23	8.48	8.74	8.99	9.24	9.49	2.4
2.5	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.76	9.01	9.26	9.51	2.5
2.6	7.02	7.27	7.52	7.77	8.02	8.27	8.52	8.78	9.03	9.28	9.53	2.6
2.7	7.04	7.29	7.54	7.79	8.04	8.29	8.54	8.80	9.05	9.30	9.55	2.7
2.8	7.06	7.31	7.56	7.81	8.06	8.31	8.57	8.82	9.07	9.32	9.57	2.8
2.9	7.08	7.33	7.58	7.83	8.08	8.33	8 59	8.84	9.09	9.34	9.59	2.9
3.0	7.10	7.35	7.60	7.85	8.10	8.36	8.61	8.86	9.11	9.36	9.61	3.0
3.1	7.12	7.37	7.62	7.87	8.13	8.38	8.63	8.88	9.13	9.38	9.64	3.1
3.2	7.14	7.39	7.64	7.89	8.15	8.40	8.65	8.90	9.15	9.41	9.66	3.2
3.3	7.16	7.41	7.66	7.92	8.17	8.42	8.67	8.92	9.18	9.43	9.68	3.3
3.4	7.18	7.43	7.69	7.94	8.19	8.44	8.69	8.94	9.20	9.45	9.70	3.4
3.5	7.20	7.45	7.71	7.96	8.21	8.46	8.71	8.96	9.22	9.47	9.72	3.5
3.6	7.22	7.48	7.73	7.98	8.23	8.48	8.73	8.98	9.24	9.49	9.74	3.6
3.7	7.24	7.50	7.75	8.00	8.25	8.50	8.75	9.00	9.26	9.51	9.76	3.7
3.8	7.26	7.52	7.77	8.02	8.27	8.52	8.77	9.02	9.28	9.53	9.78	3.8
3.9	7.28	7.54	7.79	8.04	8.29	8.54	8.79	9.04	9.30	9.55	9.80	3.9
4.0	7.30	7.56	7.81	8.06	8.31	8.56	8.81	9.06	9.32	9.57	9.83	4.0
4.1	7.32	7.58	7.83	8.08	8.33	8.58	8.83	9.08	9.34	9.59	9.85	4.1
4.2	7.34	7.60	7.85	8.10	8.35	8.60	8.85	9.11	9.36	9.62	9.87	4.2
4.3	7.36	7.62	7.87	8.12	8.37	8.62	8.88	9.13	9.38	9.64	8.89	4.3
4.4	7.38	7.64	7.89	8.14	8.39	8.64	8.90	9.15	9.40	9.66	9.91	4.4
4.5	7.40	7.66	7.91	8.16	8.41	8.66	8.92	9.17	9.42	9.68	9.93	4.5
4.6	7.43	7.68	7.93	8.18	8.43	8.68	8.94	9.19	9.44	9.70	9.95	4.6
4.7	7.45	7.70	7.95	8.20	8.45	8.70	8.96	9.21	9.46	9.72	9.97	4.7
4.8	7.47	7.72	7.97	8.22	8.47	8.72	8.98	9.23	9.48	9.74	9.99	4.8
4.9	7.49	7.74	7.99	8.24	8.49	8.74	9.00	9.25	9.50	9.76	10.01	4.9
5.0	7.51	7.76	8.01	8.26	8.51	8.76	9.02	9.27	9.52	8.78	10.03	5.0
5.1	7.53	7.78	8.03	8.28	8.53	8.79	9.04	9.29	9.54	9.80	10.05	5.1
5.2	7.55	7.80	8.05	8.30	8.55	8.81	9.06	9.31	9.56	9.82	10.07	5.2
5.3	7.57	7.82	8.07	8.32	8.57	8.83	9.08	9.33	9.58	9.84	10.09	5.3
5.4	7.59	7.84	8.09	8.34	8.60	8.85	9.10	9.36	9.61	9.86	10.11	5.4
5.5	7.61	7.86	8.11	8.36	8.62	8.87	9.12	9.38	9.63	9.88	10.13	5.5
5.6	7.63	7.88	8.13	8.39	8.64	8.89	9.15	9.40	9.65	9.90	10 15	5.6
5.7	7.65	7.90	8.15	8.41	8.66	8.91	9.17	9.42	9.67	9.92	10.17	5.7
5.8	7.67	7.92	8.17	8.43	8.68	8.94	9.19	9.44	9.69	9.94	10.19	5.8
5.9	7.69	7.94	8.20	8.45	8.70	8.96	9.21	9.46	9.71	9.96	10.22	5.9
6.0	7.71	7.96	8.22	8.47	8.72	8.98	9.23	9.48	9.73	9.98	10.24	6.0

By means of the methods given, any person of ordinary intelligence and skill, can, with a little practice, readily determine the value of milk quite accurately.

All lactometer readings must be taken before the milk is sour. Quite a number of formulas have been made for estimating solids not fat from the specific gravity and the per cent of fat. The table here given is made from one published by Dr. Babcock, in the report of the Wisconsin Agricultural Experiment Station for 1895.

The apparatus for these tests can be obtained from most dealers in dairy supplies. The Quevenne lactometer should always be ordered to use with the table given.

THE NEW POULTRY PLANT.

G. M. Gowell.

The poultry industry of the State has already assumed large proportions. For three or four years the station management has desired to undertake experimental work along these lines, but until the current year (1897) it has not been practicable to make a beginning. The station funds are definitely limited, and it is impossible to undertake a new line of work without reducing the amount of work in other directions. For this reason, only a small amount of money could be devoted to the establishment of a poultry plant. The buildings are plain and practical in every respect, and can be readily duplicated or adapted by any one entering upon the business.

In the planning and construction of these buildings we endeavored to secure such conditions as are necessary for the welfare and productiveness of the birds, and to economize the labor involved in their care as much as possible. This we tried to secure at as small cost as was consistent with quality. They are well constructed and covered, and should last as long as our barns, stables, or other wooden buildings. Not a single part of them was made for show. True, we could have secured buildings at much less cost, but they would not have met the requirements of our climate, or given protection from dampness that prevails in single walled houses.

INCUBATOR ROOM.

A wing of the well lighted cellar of the farm house is partitioned off from the main cellar for an incubator room. It is 18x24 feet and 7 feet high, and has a cement floor. Its windows are on the north and south sides. The south ones are shaded in sunny weather. This room is free from drafts, and is not much affected by outside temperature. The humidity is considerably affected during the wet weather of early spring

and the incubators have to be adjusted to the changes as they occur. At present the room contains two 600 egg size "Monarch" incubators, one 132 egg size "Peep O'Day," and one 400 egg size "Excelsior" incubators.

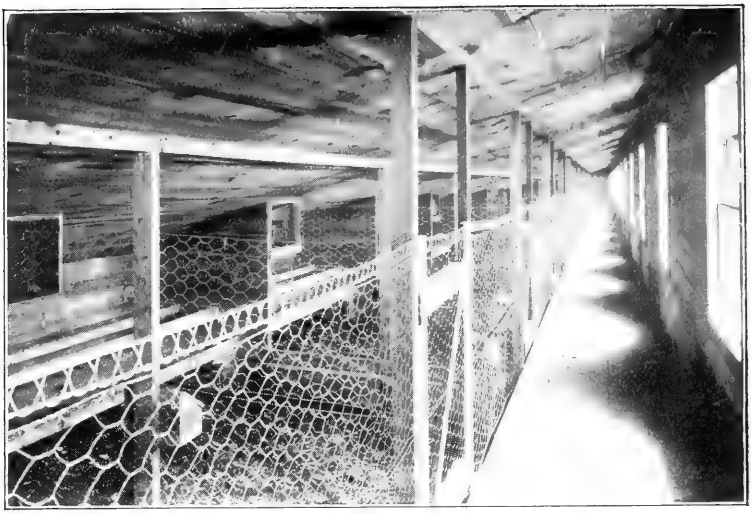
BREEDING HOUSE.

The ground upon which the poultry buildings are located slopes somewhat to the south and east, and gives good surface drainage. The soil is reddish loam, inclining quite strongly to clay, and is rather heavy for yards and walks in wet weather.

The breeding house is 16 feet wide and 150 feet long. It faces the south and conforms nearly to the land surface, the east end being 5 feet lower than the west end. The sills are of 4x6 inch hemlock, placed flat upon a rough stone wall which rests upon the ground surface, and varies from 1 to 2 feet in height. The earth is graded up to within 6 inches of the sills on the outside.

The floor timbers are 2x8 inch plank, placed 2½ feet apart, and are halved on to the sills. The studs for the back wall are 2x4 stuff, 5 feet 8 inches long, and rest on the sills. The front studs are 10 feet 6 inches long. All studs are set 3 feet apart. The plates and rafters are of 2x4 stuff. The rafters are 3 feet apart. Each 10 feet in length of the front of the building has one 12 light window of 10x12 glass. The top of this window comes within one foot of the plate. Directly underneath these windows, and 6 inches above the floor, are other 3 light windows of 10x12 glass. There is a door in each end 3x6 feet. The building is boarded and papered all over outside, and the ends and back wall are shingled, while the front wall is ceiled with matched boards.

The floor is 2 thicknesses of hemlock boards. The entire inside—walls and roof—is papered on studs and rafters with black Neponset sheathing paper. All edges of the paper lap on studs or rafters, as they are the right distance apart to take the width of the paper. This insures a tight paper wall. The paper is covered with planed pine boards, giving a smooth surface to the inside of the building. This gives a tight dead air space over the whole building, walls and roof. A 4x4 inch plate, supported by studs, run through the centre of the building.



NEW POULTRY HOUSE—INTERIOR.

NEW POULTRY HOUSE—EXTERIOR.

The building is divided into 15 sections. The close partitions between the pens are 2 feet high and made of 2 inch plank. These 2 inch partitions form strong trusses to which the studs supporting the central plate are thoroughly nailed. This saves the floor from sagging from the weight of the roof when it is covered with snow. An elevated plank walk, 4 feet wide, runs along the whole length of the front of the building, and rests on the cross partitions just mentioned. The walk, being 2 feet above the floor, allows the hens to occupy the whole floor space. This part of the floor is lighted from the front by the small windows spoken of above. Above the close partition, the pens are separated from each other and from the walk by wire netting of 2 inch mesh. A light wooden frame door, covered with wire and hung with spring hinges, leads from the walk down 3 steps, each a foot wide, into the pens.

The back ends of the cross partitions, 4 feet out from the back wall, are carried up to the roof, so as to protect the birds from currents of air while on the roosts. The roost platform is along the back wall. It is 3 feet 2 inches wide and is raised 2 feet above the floor. There are 2 roosts made of 2x2½ inch spruce, with cross pieces nailed firmly across each end. This roost frame is hinged to the back wall of the house and is readily turned up out of the way when the platform is to be cleaned off. The roosts are 10 inches above the platform; the back one is 1 foot from the wall and the front one is 1 foot 4 inches farther away.

Two sliding nest boxes are hung under the platform in each pen. These boxes are 1 foot wide, 1 foot deep, and 3 feet long, with a low partition across the middle, and a hinged door in front through which to remove eggs. The hens enter through the back end, which is always open. The darkness in the inner nest box tends to prevent them from learning the habit of egg eating. The nest boxes are readily pulled out and carried out of doors for cleaning.

A coop 2x2½ feet is hung in each pen, in which to confine would-be sitters and extra males.

A feed trough 8 inches wide is hinged to the partition, 8 inches above the floor, and is turned up out of the way and

hasped, except when used for the feeding of the morning's mash. Eight inches above the floor, a slot 8 inches wide and 4 inches high is cut through the plank partitions between every other pen. Galvanized iron pans 4 inches deep, 12 inches square at the top and 10 inches square at the bottom, are slipped into the slots, and each one accommodates two pens with water. A cleat on each side of the slot at the bottom is necessary to give sufficient base rest to the pans. Shelf troughs, 10 inches above the floor, contain grit, shell and bone.

A small box, with sloping cover, is hung on the wall in each pen and receives the eggs as they are collected during the day.

Partial ventilation is provided by eight ventilator places in the front wall between the studs. These places between the studs are 3 feet wide by 4 inches deep, and open into the pens, 6 inches above the floor. They open on both sides of every other cross partition and so ventilate from every pen. They have an upright draft of about 10 feet, and open out just under the plate, the openings being protected by sloping board covers to prevent inward currents of air when the wind blows hard against them.

All windows are double. Eight of the large outside ones are hinged at the tops and are kept hasped out one foot at the bottom except in the roughest weather. This furnishes excellent ventilation without drafts as the position of the outside windows prevents strong currents of air from entering.

When the temperature has fallen to 10 degrees below zero, water has frozen quite hard in the breeding house and egg production has been seriously checked. We shall probably provide five or six large oil stoves for use in this building during nights in extreme weather, and try to keep it above the freezing point at all times.

Double doors, 10 inches wide and 12 inches high, are placed under the walk and admit the birds to the front yards which are 10 feet wide and 75 feet long. Similar doors in the back wall of each pen, under the roost platforms, allow the birds to pass to the back yards, which are of the same width but somewhat longer than those in front. These back yards are particularly for use in warm weather.

The frame and outside boarding of the building are of hemlock, costing $8 per M. at the mills, a mile away. The doors

are of pine, costing $17 per M. The spruce for studs for partitions cost $12 per M. The inside ceiling is pine, having some knots and streaks of dry rot, but giving a smooth hard surface, and cost $8 per M. The hard pine sheathing on the outside front cost $15 per M. The cedar shingles on the roof cost $2 per M., and the pine shingles on the walls were $1 per M. The cost of the building completed was $705. Of this amount the material cost $515 and the labor, which was partly contract and partly by the day, cost $190.

The front yard fences are 6 feet in height. Two feet at the bottom is of boards and the 4 feet above of 2-inch mesh, No. 19 wire. The yards and gates cost completed, $65. The back yard fences are not yet constructed.

BROODING HOUSES.

In the spring of 1897 six movable brooder houses were made and located on the grass land conveniently near the farm buildings. These houses are each 6 feet by 12 feet and 5 feet high at the front, and 4 feet at the back, with a door and window in the front.

Two Peep O'Day brooders were put in each house and separated from each other by a wire partition. Each house had two separate yards. In these six houses nine hundred Brahma and Plymouth Rock chickens were raised until October, when the pullets were put into winter quarters and the houses drawn together by a pair of horses, so as to be ready for use again early next spring.

In the fall of 1897 a permanent brooding house was constructed and equipped for use. This house is 14 feet wide and 60 feet long. Its front wall is 4 feet 10 inches high from bottom of sill to top of plate and the back is 7 feet high. The ridge is 4 feet in from, and 1 foot and 6 inches higher, than the back plate. This gives the short part of the roof back of the ridge and the long part to the front of it.

This building is constructed in the same manner and of the same material as the breeding house. It has the 4 inch dead air space in walls and roof, and the tight double floor. The front wall is 3 feet 8 inches high inside and the back wall is 5 feet 9 inches from floor to ceiling. There is a 3x6 feet door in

each side. There are ten windows in the front wall, equal distances apart. The bottoms of these windows are 8 inches from the floor. There are also five windows in the back wall close up to the plate. These windows all have six lights each of 10 by 12 glass.

All sash are in two parts and slide up or down to admit fresh air and keep the house cool in warm weather. All windows are double. There are ten small doors each 10 by 12 inches, placed close to the floor, along the front wall, through which chicks can pass in and out. All doors are double.

Two galvanized iron ventilators, each 10 inches in diameter and 6 feet 6 inches high, with projecting hoods at the tops, extend from the inside of the room up through the ridge, and furnish sufficient means of ventilation during cold weather. Ventilation is regulated by means of a shut off at the ceiling.

There are ten breeding pens, each 6 feet by 10 feet and 8 inches. The partitions have an 8 inch board at the bottom with 3 feet of 1-inch mesh wire above. A walk 2 feet and 6 inches wide extends along the back of the building. The doors which lead from the walk to the pens swing both ways and are wire covered. A Peep O'Day brooder is placed in each pen with the lamp door opening into the walk. Each of these pens accommodates about 60 chicks in winter or 75 or 80 in spring when they can get out into the yards.

The building being low is kept warm enough in winter by the ten brooder stoves, and the temperature under the hovers is easily kept so that it is found in the morning about as left the night before.

The cost of this building without the brooders was $235. Of this amount $160 was for material and $75 for labor.

FEED HOUSE.

The east end of the brooding house is 25 feet west of the west end of the breeding house. The fronts of both buildings are on the same line, facing the south. The 25 feet space is filled in with a small temporary cook and feed mixing-house, which opens into the breeding and brooding houses. It contains a supply of running water, mixing trough, feed bins, water heater, clover cutter, bone mill, etc.

It is designed to erect in its stead, at some future time, a permanent two-story building, the lower floor to be used for mixing and cooking feed, and the upper floor for storage, feather curing, and a sleeping room for the poultryman.

EXPERIMENTS.

The plant was constructed for the purpose of investigation, and many experiments are being planned. The houses are just completed, and at this date (December, 1897) the chief point being studied is in reference to the number of hens that can be carried in a room of a certain size, and their health and productiveness maintained.

There are 15 pens, all alike in arrangement and size, each being 10x15 feet and 2 inches. November 1st 15 Brahma pullets were put in pen No. 1, 20 pullets in pen No. 2, 25 in pen No. 3 and 30 in pen No. 4. In pens No. 5, 6, 7 and 8 similar assignments of 15, 20, 25 and 30 birds were made. In pens 9, 10, 11 and 12 the same arrangement of numbers of Plymouth Rock pullets was made and pens 13, 14 and 15 were duplicates of pens 9, 10 and 11. This gave four pens with 15 birds in each one, four pens with 20 birds, four pens with 25 birds and three pens with 30 birds each. The birds are treated alike in every pen and fed in proportion to numbers. The eggs are recorded at each collection. This and other experiments to be undertaken will be reported upon from time to time as results of importance are obtained.

ORNAMENTING HOME GROUNDS.*

W. M. MUNSON.

A constantly recurring problem in New England, is, How shall we keep the boys on the farm? The answer is not easy, but more people are driven from the farm by its isolation, loneliness and lack of tasteful surroundings than by any other cause. If the boys and girls go away to the academy for a time and get a taste of village or city life, the contrast when they return to the old farm is often too strong. For this reason any effort towards improving the surroundings of the home is labor well expended.

LOCATION.

In building a new house, consider well its location. Don't build where the old one was simply because the barns are there,—though of course, other things being equal, the barns should be near the house. Healthfulness is of the first importance, so be sure that the location of the residence is such that perfect drainage is secured. Other things being equal, a southern or southeastern aspect is most desirable.

If possible, make use of natural groves or scattering trees and of shelter-belts or windbreaks, and place your buildings near them. Nothing you can plant will be so satisfactory as the native forest trees. If there is not a natural shelter of trees, by all means provide one.

Better results may be obtained and much needless waste of time and expense may be avoided, if a definite plan of the place be made before commencing the work of improvement, though "paper gardening" is often ridiculed by so-called practical men.

The house, both because of its importance and for sanitary reasons, should, if possible, be on a slight elevation and should be so situated as to secure the best views both of your own grounds and of the surrounding landscape.

*This paper in an abridged form was published as Bulletin 42 of this Station.

The relative position of house and barns should also receive attention. It is in bad taste to have the barn in the fore ground, partially shutting off the view of the house as approach is made from either side. It is in much worse taste, indeed it is the *worst* taste, to place the barn on the opposite side of the street from the house and directly in front. The proper location of the barn is at one side and to the rear of the house.

WALKS AND DRIVES.

The best grounds are those which combine the greatest convenience with the greatest pleasure. In general, every object should be easily accessible. Walks and drives are, however, always unsightly, and there should be as few of them as is consistent with convenience. They should approach the buildings with direct curves. Indirect and reversed curves, without an apparent reason, give the idea of an attempt to "show off" the grounds unduly. When walks or drives branch or turn aside abruptly from their general course, there should be an apparent reason for such change of course. This may be accomplished by placing some obstruction, as a group of shrubs at the angle or turn.

In the construction of walks and drives the natural undulations of the surface should be followed, though of course sudden swells or dips should be avoided. A firm bottom should be secured by excavating somewhat as shown in the cut. The

trench thus made is filled to within three inches of the surface with cobble stones, coal ashes, etc., placing the coarser material near the sides to insure drainage. At least three inches of gravel should be placed above the coarser material, and this should be slightly convex at the surface—not so much so, however, as the bottom. Both the gravel and the coarser material in the bottom should be packed very firmly.

THE LAWN.

A good lawn is the most essential element of beauty in any grounds and in these days of cheap lawn mowers there is no excuse for not having a neat lawn in front of the humblest

dwelling. It is very little more work to leave the surface of the ground smooth after the final grading about the buildings than it is to leave it rough and uneven. Arrange if possible, to have a few inches of good loam on the surface when the grading is completed, and in any case, make a liberal application of well rotted stable manure. After thorough preparation and raking with a hand rake, seed very thickly, using three to five bushels of seed per acre. After the seed is sown, roll and if late in the season or the soil is very dry, mulch with chaff or fine manure or leaf mould. Keep the grass closely clipped during the summer. In this way only can the weeds be kept down and a thick velvety turf be formed. In the latter part of the season it is well to let the grass become longer, for the double purpose of strengthening the roots and of serving as a mulch during the winter.

The best grasses for a lawn are Kentucky Blue Grass and Red Top, with a slight admixture of White Clover on heavy soils. Rhode Island Bent is also a valuable grass for heavy clay soils. On a sandy loam, Kentucky Blue Grass alone will be found as satisfactory as anything.

As to the care of the lawn but little need be said. In the spring it is well to rake off dead leaves and roll the ground, but the practice of burning over the lawn is not to be recommended. A lawn mower is necessary to insure good results. A very good machine can be procured for $5, and the labor of mowing in this way is very light.

On small surfaces a lawn may be formed more quickly and better by turfing than by seeding. For this operation the surface should be prepared as for seeding. Then from some well established lawn or from an old pasture procure sods about one and one-half inches thick. These should be as nearly as possible of a uniform width and thickness, and should be cut into strips several feet long rather than in squares. The strips may be made into compact rolls for moving to the desired place. In laying the turf be careful to make good joints and when it is in place beat it thoroughly with a heavy wooden mallet.

About two years will usually be required to free a newly seeded lawn from weeds. Close clipping will keep most weeds in check but it may be necessary to dig the roots of some, e. g. mallow, fall dandelion, etc.

The use of stable manure, unless it has been thoroughly heated and rotted to kill all weed seeds, is to be discouraged. Instead of manure, an application of concentrated fertilizer rich in phosphoric acid is to be preferred.

THE FLOWER GARDEN.

While, as a rule, better results may be obtained for the same expenditure of time and labor by using shrubs and perennials, the old fashioned flower garden of our grandmothers is not out of place on the farm. In many cases the taste—or lack of taste—of the occupants of a home are here most vividly portrayed.

Many genuine lovers of flowers fail to realize the difficulty in securing a constant succession of beauty both in blossom and leaf. Indeed there are very few collections which can be considered in any way satisfactory.

The leading faults that are met in all of our flower gardens are the want of proper selection in the plants and a faulty arrangement. A flower garden should be rich and attractive during the whole summer and autumn, hence the importance of avoiding plants which from their coarse straggling habit, or sparseness of bloom give a confused or meagre effect. The best effects will be produced from the use of a few species or varieties which combine beauty of form with the habit of perpetual blooming.

Among shrubs, such as will give a succession of bloom and will present attractive foliage during the remainder of the season, should be chosen. For example, the old fashioned roses which bloom but once during the season, should be discarded for the hybrid perpetuals and Rosa rugosa. Among annuals all short lived species should be rejected and instead, such plants as portulacca, verbena, petunia, Phlox Drummondii, calundula, asters, pansies, etc., should be used.

The good effect from a careful selection of plants may be enhanced by exercising proper care in grouping or massing colors and particular species of plants. Masses of white and crimson, of yellow and purple, and other shades and colors brought boldly into contrast or so placed as to form an agree-

able harmony will produce a much more forcible and pleasing impression than is possible when the various shades and colors are thrown together indiscriminately. The bringing together of masses of colors in this way gives a breadth of effect, which is entirely lost by the other mode.

As to the location of the "flower garden" but little need be said. In general it should be at one side and a little to the rear of the house rather than directly in front, and although "fashion" may sanction the practice, do not torture your neighbors by arranging a display of pots and kettles, wash-tubs and churns painted a glaring red, in solemn array before the house—as if to remind passers by of the blood of the martyrs.

WHAT TO PLANT.

The selection of trees and shrubs for planting is always perplexing. A few general principles may aid in solving the problem:

1. Do not attempt too much. Grounds that are crowded, even though the plants of themselves may be choice, have the appearance of an overdressed person.

2. Do not discard native plants because they are "common." The oaks, maples, hickories and elms; the viburnums, dogwoods, roses and sumacs are unsurpassed in their respective classes. We might name further the hawthorns, the wild crab, the wild cherry and plum, the shadbush and tamarack, the white ash and many others of special value and easy to be obtained.

3. Do not invest freely in untried things. If you have enterprising and experienced neighbors, consult with them before ordering nursery stock. Otherwise correspond with some reliable nursery firm or with some person in whose judgment you have confidence for advice in specific cases. It is usually safer to place an order directly with some reliable firm rather than with an agent. As a rule you will pay an agent 50 to 100 per cent more than the same goods would cost if purchased direct, and are less likely to receive them in good condition. It is often practicable for several neighbors to unite in sending an order and thus get wholesale rates.

4. In making a selection of flowering trees and shrubs, aim to secure a succession of bloom, in order that the grounds may

be attractive all summer. Among the earliest flowering hardy shrubs are Daphne mezereum and the Forsythias which bloom before putting forth leaves—usually about the first of May. Following these shrubs are the Magnolias, the Red Bud or Judas Tree, the Hawthorns, the apple and the cherry among small trees. The magnolia will succeed only in the southern counties. Some of the best second early shrubs are the Azalias, Bush Honeysuckle, Japan Quince, Double Flowering Plum, Flowering Almond, Lilacs in variety and the earlier Spiraeas—especially Van Houteii, prunifolia and Thunbergii. A little later come the Weigelas and Mock Orange (Philadelphus) and the Japanese Rosa rugosa. In late summer we have the late Spiraeas—as Bumalda, Billardi, Callosa, etc.,—the "Smoke Bush" (Rhus cotinus) and, best of all for massing, the hardy Hydrangea.

The brightness produced by bulbs and hardy perennials will well repay a small outlay in this direction. In earliest spring we have the Christmas Rose (Helleborus niger), the Snowdrops (*Galanthus*), Crocuses and Pansies. A little later Tulips and Hyacinths appear, and these are followed by Columbines, Lily-of-the-Valley, "Bleeding Heart" (*Dicentra*) and Peony. In summer and early fall, the Japan Anemone, the Golden Columbine (*Aquilegia Chrysantha*), the Foxglove, Hollyhock, Plantain Lily (*Funkia*) and the numerous species and varieties of true lilies are all very effective and are easy of culture.

WHEN TO PLANT.

But for the difficulty of obtaining well matured stock in the fall, I should advocate setting most trees and shrubs in September and October; because of this difficulty, however, spring planting is usually advisable. All planting should be done just as early in the spring as possible that the trees or shrubs may become well established before the leaves are put forth.

Hardy herbaceous perennials such as phlox, digitalis, hollyhock, columbine, etc., should, as a rule, be planted in September. The same is true of most bulbous plants, including the crocus, hyacinths, lilies, tulips, etc. The gladiolus is usually set in spring.

HOW TO PLANT.

In working with trees and shrubs, remember that a plant is a living organism and is as truly sensitive to neglect or ill treatment as is an animal. In handling nursery stock, always be careful to keep the roots moist. When received from the nursery the bundles should at once be opened and the plants carefully "heeled in." In case any of the plants are very dry and withered, they should be completely covered with earth for several days. In this way many plants which if set immediately would die, may be saved.

If a tree could be removed with all of its rootlets and placed in the soil exactly as it stood before, it would suffer no check in transplanting; but as this is impossible, a certain amount of pruning must be done. Even with the best of care the mutilation of the roots must be great, and with careless handling nine-tenths of the root system may be destroyed. All the bruised and broken roots should be cut off with a clean smooth cut from the under side.

Now with the depleted root system the capacity of the plant for absorbing moisture from the soil is reduced to such an extent that unless the leaf surface be also reduced, the loss by evaporation soon causes the plant to wilt. Hence, before setting, the top should be cut back to correspond with the roots.

In cutting back the top, consider the habit of the plant and the desired form. If it is wished to encourage a tendency to spread, cut off the branch in each case just above a bud on the *outer* side. If, on the other hand, a more upright habit is desired, cut just above a strong bud on the *inner* side of the branch.

As a rule, a tree or shrub should not be set deeper than it sat before removal and the hole should be large enough so that none of the roots need be cramped. If the soil is not in good condition, the labor of carting in good loam, in which to set the plants, will be well expended.

If but few trees or shrubs are to be set, it is well to use water, in settling the earth about the roots. In any case, tramp the soil firmly and leave a slight mound above the base of the tree.

If the season is late, or if the soil is very dry, the roots should always be mulched. Any coarse litter that will shade the

ground will answer for this purpose—coarse manure, leaves, straw, sawdust or even boards, will answer.

ARRANGEMENT.

The effective arrangement of trees and shrubs is often a most difficult problem. One of the first things to accomplish is the screening of outbuildings and other unsightly objects. The best plants for this purpose are evergreens—especially those which appear best at a distance, as Norway Spruce, Austrian Pine or Arbor vitae (white cedar). It is not necessary that the planting be done in formal belts or hedges. Irregular groups, so arranged that the view is obstructed, are better than formal hedges. A trellis covered with vines may often be made effective and attractive as a screen. Clematis, Bittersweet, or even the common hop, may be used to advantage in such a place.

There may properly be a border of low growing shrubbery next to the house and it is well to plant a vine of some sort by the piazza. Nothing is better for this purpose than the common woodbine or Virginia Creeper. Akebia and Actinidia, two new Japanese climbers, are also good. In general, a better effect is produced by planting in masses and borders, than by dotting the plants here and there over the lawn. By the first method a picture is created with the residence as the central object, and one sees the grounds as a whole. The other method is meaningless and the effect produced is that of an orchard or nursery.

SHELTER BELTS OR WINDBREAKS.

The importance of a windbreak in exposed situations can hardly be overestimated. The saving in fuel as well as the increased comfort will well repay an outlay in this direction when planting is better done.

The best windbreak for general purposes consists of a mixed planting of evergreens and deciduous trees such as Norway Spruce, and sugar maple or elm.

FENCES.

Fences are, as a rule, unsightly and should be avoided as much as possible. High picket fences painted white are specially glaring and objectionable,—they are too suggestive of prison bars. That fence is best which is least conspicuous and best seen through. A picket fence of the ordinary height does not fill either requirement, though it is perhaps the least objectionable form of wooden fence.

In general, avoid all useless fences, but if needed, a neat, inconspicuous wire fence is best. Do not fence the "front yard," in other words do not have a front yard. Road fences are usually unnecessary and should be avoided.

SOME NATIVE TREES AND SHRUBS VALUABLE FOR PLANTING.

The following list of trees and shrubs includes only those which are most common in our forests and which may thus be obtained at slight expense.

EVERGREEN TREES.

Arbor Vitae, or White Cedar (*Thuja occidentalis*, L.).
Hemlock (*Tsuga Canadensis*, Carr.).
Pine, White (*Pinus strobus*, L.)
Pine, Norway (*P. resinosa*, Ait.).
Spruce, White (*Picea alba*, Link.).
Black (*P. niger*, Link.).

EVERGREEN SHRUBS.

Juniper (*Juniperus communis*, L.)
Laurel, Mountain Laurel, (*Kalmia latifolia*, L.).
Laurel, Sheep Laurel, (*Kalmia angustifolia*, L.).

DECIDUOUS TREES.

Ash, White (*Fraxinus Americana*, L.).
Basswood (*Tilia Americana*, L.).
Beech (*Fagus ferruginea*, Ait.).
Birch, Black or Cherry B. (*Betula lenta*, L.).
Birch, Yellow B. (*Betula lutea*, Michx.).
Gray B. (*Betula populifolia*, Ait.).
Bird Cherry (*Prunus Pennsylvanica*, L.).
Black Cherry (*Prunus serotina*, Ehrh.).
Chestnut (*Castanea Americana*, Watson).
Elm, White or American (*Ulmus Americana*, L.).
Hawthorn (*Cratægus coccinea*, L.).
Hackmatack, Tamarack or "Juniper" (*Larix Americana*, Michx.).
Maple, Rock or Sugar M. (*Acer saccharinum*, Wang.).
White or Silver M. (*Acer dasycarpum*, Ehrh.).
Red, Soft or Swamp M. (*Acer rubrum*, L.).
Mountain Ash (*Pyrus Americana*, DC.).
Oak, White (*Quercus alba*, L.).
Scarlet (*Quercus coccinea*, Wang.).
Plum, "Pomegranate" (*Prunus Americana*, Marsh.).

DECIDUOUS SHRUBS.

Black Alder or Winterberry (*Ilex verticillata*, Gray.).
Chokeberry (*Pyrus arbutifolia*, L.).
Choke-cherry (*Prunus Virginiana*, L.).
Dockmackie or Maple-leaved Arrow-wood (*Viburnum acerifolium*, L.).
Dogwood, Red Osier (*Cornus stolonifera*, Michx.).
Elder, Common or Black E. (*Sambucus Canadensis*, L.).
Red E. (*Sambucus racemosus*, L.).
High-bush Cranberry (*Viburnum Opulus*, L.).
Hobblebush (*Viburnum lantanoides*, Michx.).
Honeysuckle (*Lonicera ciliata*, Muhl.).
(*Diervilla trifida*, Moench.)
Meadowsweet (*Spiraea salicifolia*, L.).
Mountain Maple (*Acer spicatum*, Lam.).
Mountain Holly (*Nemopanthes fascicularis*, Raf.).
New Jersey Tea (*Ceanothus Americanus*, L.).
Rose (*Rosa blanda* Ait.).
(*Rosa lucida*, Ehrh.).
(*Rosa humilis*, Marsh.).
Sheep Berry (*Viburnum Lentago*, L.)
Staghorn Sumach (*Rhus typhina*, L.).
Thimble Berry (*Rubus odoratus*, L.).
Witch Hazel (*Hamamelis Virginiana*, L.).

CLIMBING VINES.

Bittersweet (*Celastrus scandens*, L.)
Clematis, Virgin's Bower (*Clematis Virginiana*, L.).
Grape (*Vitis Labrusca*, L.)
Virginia Creeper, (*Ampelopsis quinquefolia*, Michx.).

THE ACQUISITION OF ATMOSPHERIC NITROGEN.

W. M. Munson.

[Several years ago, the Director of this Station, then assistant to Professor W. O. Atwater of Wesleyan University, had the privilege of sharing in an investigation upon "The acquisition of atmospheric nitrogen by growing plants." The experiments demonstrated that certain plants had this power. The results of the first series of experiments were presented by Professor Atwater at the meeting of the American Association for the Advancement of Science in 1881. These results together with those of another series of experiments were presented by Professor Atwater at the meeting of the British Association for the Advancement of Science in 1884, and were published in detail in the American Chemical Journal for February, 1885. The investigation was interrupted for four years, and in the mean time the results were confirmed by other experimenters. Notable among these is Hellriegel, who showed that in some way the enlargements of the roots (root nodules or tubercles) are concerned in the fixation of the nitrogen of the air. After the establishment of the Storrs (Conn.) Experiment Station these investigations were continued by Professor Atwater and the writer. A number of allied questions were studied, including the losses of nitrogen which occur in germinating seeds and in growing plants. The last important experiment was an investigation in which it was shown that it was the free (uncombined) nitrogen of the air which peas and allied plants have the power of acquiring. The results of this investigation were given in the report of the Storrs Station for 1892.

In 1897, it was deemed advisable to undertake an investigation here with special reference to the practical application of the principles already established. During the past few years a large amount of work, from many different standpoints, has

been undertaken by different investigators. In beginning our investigations it was found that no satisfactory summary of the work was available in any language. For this reason a somewhat extended study of the literature of the subject was necessary and the general facts obtained are herewith presented by Professor Munson. The bibliography, although incomplete, is given as an aid to others working on this subject. Chas. D. Woods.]

NITROGEN ACCUMULATING PLANTS.

The most important discovery in vegetable physiology in its relation to agricultural science, which has been made during the present generation, is that of the relation between microörganisms and the acquisition of atmospheric nitrogen by plants.

A review of the question of assimilation of free nitrogen by plants would necessarily be disconnected, since the subject has been approached from so many different points of view. It is not our purpose at this time, however, to make an exhaustive study of the subject, but rather to bring it into view and call attention to its economic importance.

The results of several hundred experiments have shown conclusively that many if not all of the more common species of legumes are capable of using atmospheric nitrogen. Peas, beans, vetches, clover, alfalfa, lupine, soja bean, sainfoin, serradella and many other species have been used in the experiments.

NATURE OF THE TUBERCLE ORGANISMS.

The tubercles were observed as early as 1615,* but their origin and significance have not been well understood. At first the tubercles were supposed by some to be caused by a parasitic fungus; others supposed them due to the attack of insects or worms (*Anguillulidae*.) They were then regarded as rudimentary roots or as buds which might develop in case the plant did not fruit.

In 1866 Woronin† made a careful study of the subject and found in the tubercles numerous bodies resembling bacteria. Because of the regularity of the organisms which were often

*De Lechamp, *Histoire generale des plantes*, cited by Vuillemin, Ann. d. Sci. Agronom. franç. et etrang., 1888, p. 96.

†Mem. Acad. imp. des Sci. de St. Petersburg, t. X, (1866) No. 6.

branched into T or Y shaped bodies, it was impossible to determine whether they were true bacteria. They were therefore called by the discoverer bacteroids. This contribution marks the beginning of serious investigation as to the nature and etiology of the tubercles.

A few years later, Erickson* found that in the early stages of the tubercles, long branching threads, like the mycelium of fungi, were present but he was unable to determine whether there was any connection between these and the bacteroids which appeared later.

Other experimenters a little later concluded, as already indicated, that the tubercles were normal parts of the plant and had no connection with infection from without. The bacteroids were observed but were not considered distinct organisms. They were considered rather as differentiated portions of the proteid contents of the cells which were later absorbed by the plant. This was the view of Brunchorst;† also of Sorauer,‡ Van Tieghem and Duliot¶ and others.

In 1887, Marshall Ward proved conclusively§ that the tubercles are caused by some organism which is abundant in the soil, apparently a parasitic fungus.

In 1888, Beyerinck§§ undertook the cultivation of the organism in artificial media and was confident he could trace the development of the bacteroids from a bacterium which he named *Bacillus radicicola*. The bacteroids were regarded as degenerate forms appearing only after the bacteria had lost their vigor.

In 1890, Prazmowski published the results of extended researches,** the results of which are so concisely summarized by Conn†† in the Experiment Station Record, that I take the liberty of quoting freely in this connection.

According to the investigations of Prazmowski the development and growth of the tubercles are as follows: *Bacterium radicicola* lives normally in the earth and collects in numbers on

*Studier öfver Leguminosernas Rotknöler Lund, 1874; Bot. Zeitung 1874, p. 381.
†Ber.d. Deutsch. Bot. Gesell. III (1885), pp. 241, 257.
‡Bot. Centralb. XXXI, (1887), 308.
¶Bull. d. Soc. Bot. France, XXXV (1888).
§Phil. Trans. Roy. Soc. CLXXVIII (1887), 139-562.
§§Bot. Zeitung. Bd. 46, (1888), p. 725 *et seq.*
**Landw. Versuch. Stationen, 37, p. 161.
††Expt. Sta. Record II, 689, (1891).

the outside of the roots of various legumes. Some of the organisms succeed in forcing their way into the tissues of the young roots, though they are not able to pierce the older roots. For a while they may remain in the root as free bacteria, but the plant plasma seems to exert an injurious influence upon them, for very soon a thin membrane is formed around the bacteria masses, inclosing them like a pouch. Prazmowski thinks that this membrane is a product of the bacteria themselves, formed for the purpose of protecting them from the injurious action of the plant tissue. The bacteria which do not succeed in getting into one of these pouches soon cease to grow and degenerate into irregular forms like the bacteroids which appear later in greater numbers. The bulk of the bacteria, however, become enclosed in the membrane, after which they continue their growth with much vigor. The pouches begin to grow into threadlike masses, and these make their way among the cells of the root. The thread branches more or less as it lengthens and its various filaments grow through and between the cells, soon permeating the root with a fine, branching filament, which looks much like the mycelium of a mold. It was this bacteria pouch which was first seen by Erickson, and which previous observers regarded as the hypha of some low fungus. Instead of being a mycelium growth of a mold the thread is nothing more than a large, branching colony of bacteria inclosed in a thin membrane.

"The growth of this colony of bacteria among the cells of the root stimulates these cells to an unusual growth. They multiply more rapidly than usual, and thus soon produce a swelling on the root which is the beginning of the tubercle. While this rapid multiplication of root cells is going on, the bacteria pouch continues to grow, and swells out into rounded vesicles within the cells which lie at the center of the forming tubercle until most of them become filled with these expanded portions of the bacteria thread. Meantime the root cells of the plant have been rapidly growing, and form around the cells containing the bacteria several layers of smaller cells, which develop into a hard, corky covering forming a coat around the tubercle. This seems to be impervious to the bacteria thread, and confines the bacteria within its limits.

"The bacteria colony now undergoes a change. Although Prazmowski has not been able to follow the details of the pro-

cess, it is thought that the vesicles in the central cells swell until the membrane covering the bacteria is so thin that it bursts, and the bacteria are themselves extruded into the plasma of the root cells. At all events, the vesicles disappear and there appears in their place what is called the bacteroid tissue. His interpretation of this is that the vesicles burst and the bacteria coming into the cell plasma are immediately checked in their growth by the injurious influence of this plasma and begin to undergo involution changes. Instead of multiplying in the normal manner, they asume various abnormal forms which have no further power of growth. They become, in short, the bacteroids which have been found by so many observers, filling the central cells of the tubercle. The bacteria retain their power of growth only so long as they remain in the protecting covering of the membrane.

"The tubercle by this time is pretty well formed. The outer cells have undergone quite an extended growth and differentiation, so that the tubercle is really a structure of a rather high grade of plant tissue. The tubercle itself is thus really a growth of the root cells of the plant and not a growth of bacteria. But in the centre of this mass of plant tissue are a large number of cells, which are completely filled with the so-called bacteroids. These bacteroids give to the tubercle at this stage a flesh-red color. Some of these central cells are so completely filled with them that nothing else can be seen, while others may show the nucleus. In others, spaces begin to appear in the body of the cell. The appearance of the spaces marks a new stage in the history of the tubercle, and indicates that the bacteroids entirely cease their activities and begin to disappear rapidly. After a little they are completely absorbed by the substance of the plant and the tubercles are left as empty pouches. The tubercles have now changed their appearance again and assume a somewhat grayish green color.

"This practically ends the history of the tubercle. In most cases some of the bacteria seem to remain within their original membrane, and therefore are capable of growing. These may now set up a secondary growth, but it amounts to little, for by this time the plant has usually blossomed, ripened the seeds, and the root is beginning to die. The tubercle is immediately

attacked by the putrefactive bacteria in the soil and becomes decomposed."

Frank has also published an extended series of observations upon the same subject.* While he differs from Prazmowski in some important particulars, his later results, on the whole, confirm those of the latter writer. He finds the tubercles produced as the result of infection by some organism in the soil, and he describes the organism as a micrococcus or short rod,—very probably the same as that studied by Prazmowski. His explanation of the hyphae and the bacteroids is different from the one just noticed. The hyphae he finds filled with bacteria, as does Prazmowski, but he regards the membrane that surrounds them as a product of the root cells rather than of the bacteria. He thinks that the root cells produce these peculiar threadlike forms in which the bacteria multiply, and that by means of the threads the bacteria are conducted into the inner cells of the root to produce the infections there. He therefore calls them "infection threads."

The essential point in which Frank's theory differs from that of Prazmowski is, in regarding the filaments as products of the root cells instead of the bacteria. He thinks that in some cases the infection occurs without the development of the filaments. After the infection, the cells of the roots are stimulated into growth to form the tubercle, as already described, and bacteroids appear in the central cells. Frank, however, regards the bacteroids as peculiar formations of the plant tissue and not as distinct organisms or degenerate bacteria. According to him the presence of the bacteria produces abnormal changes in the plasma of the root cells, causing it to become separated into numerous irregular masses which contain the bacteria inside of them. These masses are the bacteroids which fill the central cells. They are subsequently absorbed by the plant in the manner described by Prazmowski.

In a series of experiments performed at the Pasteur Institute, Paris, Laurent† reaches a different conclusion. In his studies of pure cultures of the tubercle organism, he finds that in gelatin the organisms spontaneously assume, by a sort of bud-

*Landw. Jahr., Bd. 17, (1888), pp. 421-552, and 19, (1890), pp. 523-640.

†Ann. d. L'Institute Pasteur, 1891, No. 2.

ding, the irregular forms which have been called bacteroids. The bacteroids are, therefore, not degenerate, but normal forms of the bacteria. He further asserts that the bacteroids found in the tissue of the tubercles arise by a normal process of budding from the hyphae. The hyphae themselves he looks upon as filamentous growths of the organism, and not as pouches filled with bacteria nor as products of the root cells. Now, since bacteria always multiply by division and never by budding, it is plain that if these observations of Laurent are correct, the organisms in question cannot be called bacteria. Laurent, therefore, like Ward and other earlier investigators, affirms that the organism is really a low fungus, related to the yeasts in its method of growth, and regards it as intermediate between the yeasts and the filamentous fungi. He accepts the name formerly suggested by Frank, *Rhizobium leguminosarum*.

The three views thus outlined give in substance our present knowledge of the origin and structure of these tubercles. It may seem strange that there should be such a difference of opinion on mere matters of fact, but as indicated by Conn,* the differences are explained by the difficulties of observation. The tubercles grow naturally under ground, Laurent alone having had much success with water culture. They are opaque, and can therefore only be studied by tearing them to pieces or by cutting sections of them. The only method of observation is by examining a large number of tubercles in different stages of growth, and in this way important points are sure to be missed. Differences in results of observation as wide as above sketched are, therefore, not surprising.

Our present knowledge of the nature of these tubercles is somewhat as follows:† "They are not normal products of the plant, but are in all cases produced by infection from some organisms which exist in the soil and attach themselves to the young roots. Their presence in the tissue stimulates the root cells to active growth and a mass of new tissue is formed around the growing organisms. This tissue forms the tubercle and confines the infectious action within narrow limits. The tubercle is thus a sort of gall. The study of the development of this

*Conn, l. c.
†Conn, l. c.

gall shows three somewhat distinct stages. First there appears a branching filament which grows among the cells of the root and which soon stimulates an active growth of the root cells. A little later, after the tubercle is formed, the central cells become filled with the bodies called bacteroids. Lastly the bacteroids of the central cells are absorbed by the plant and the tubercle becomes empty. These facts are agreed upon by all.

In regard to the significance of these facts there are three distinct opinions. The first is that of Prazmowski, who calls the organism which produces the infection a bacterium, and claims that the branching filaments are simply colonies of bacteria inclosed in a membrane of their own manufacture, for their protection against the injurious action of the plant tissue. The filaments swell with the multiplication of the bacteria until they burst. The bacteria then coming into contact with the plant tissue and no longer being able to grow, owing to an injurious influence of the plant plasma upon them, degenerate into the bacteroids. They are subsequently absorbed by the plant and incorporated into the substance, serving therefore as food.

"The view held by Frank differs from this essentially in its explanation of the filaments and bacteroids. The filaments are said to be a mixture of plant protoplasm and bacteria. They are produced by the plant and serve to conduct the infectious matter into the midst of the root. The bacteroids are also products of the plant plasma and not distinct organisms. Their absorption does not, therefore, especially help the plant.

"The third view, that of Ward and Laurent, regards the infecting organism not as a bacterium, but as a low fungus, somewhat closely related to the yeasts. The filament is really a mycelial growth of the organism, and the bacteroids arise from it by budding. The bacteroids are thus distinct organisms—not degenerate forms, but normal growths.

"None of these views would regard the tubercle organisms as true parasites on the plant, since the plant is not injured by them, but is probably directly benefited. The association is rather to be regarded as an instance of symbiosis, an association of two organisms together in such a way that each receives benefit from the other. The plant is probably benefited in gaining nitrogen, and the infecting organism is benefited in gaining a brood pouch for its development."

HOW IS THE NITROGEN FIXED?

There has been a question whether, under the influence of the symbiosis, the higher plant was enabled to fix the free nitrogen of the air by its leaves. It seems probable, however, that the nodule-bacteria fix the nitrogen within the plant, and that the higher plant then absorbs the nitrogenous compounds produced.

Among the most important recent contributions to the subject are those of Nobbe and Hiltner, who claim* that the assimilation bears a direct relation to the formation of bacteroids. In many cases plants growing in rich soil and well supplied with nodules, when inoculated with pure cultures of *Bacillus radicicola* behaved very differently; some growing considerably in the amount of nitrogen, and others apparently suffering from nitrogen hunger. Examination proved that the nodule producing organisms were unchanged in the weak plants, while in the thrifty ones the bacteria were changed to bacteroids. The conclusions drawn were that "(1) tubercles in which bacteroid formation does not occur are injurious instead of beneficial to the host plant (the unchanged bacteria are then merely parasites;) (2) the unchanged bacteria present in tubercles seem to have no relation to the nitrogen fixation by legumes; (3) the more vigorous the bacteria the less tendency there is toward bacteroid formation; (4) the assimilation of nitrogen begins with the formation of bacteroids."†

Nobbe and Hiltner claim further that the bacteroids are formed by repeated division of the tubercle germ without the separation into isolated individuals. This continued division usually takes place transversely, producing an elongated growth, although lateral protuberances often arise making a branched and irregular appearance. They liken the swollen branched bacteroids to a gill respiration, the nitrogen being absorbed by the water and thus coming to the absorbing surfaces in a dissolved condition.‡

*Landw. Vers. Stat. 42: 459 *et seq.*
†Cited by Russell, Bot. Gaz. 19, 291, (1884).
‡Ibid.

ARE THERE SEVERAL SPECIES OF NODULE-PRODUCING ORGANISMS?

The fact that many different forms of bacteroids have been noted among the different species of legumes, has led to the view that each species of leguminous plant may have its specific nodule-producing bacterium. In nitrogen-free soils, as shown by Nobbe and Hiltner,* *Lupinus luteus, L. augustifolius* and some of the Acacias, produce tubercles when inoculated with bacteria of pea and bean tubercles, but when nitrogen was present in the soil, no infection occurred; an indication that nitrogen hunger is an important factor.

Bolley has observed† that many of the introduced legumes, especially *Trifolium pratense,* often fail to establish themselves in the virgin soil of the prairie, even though native leguminous species may be abundant. On the other hand, when preceded by *Trifolium repens,* the red clover develops tubercles and is thrifty.

Schneider‡ has classified the various forms under the general name of *Rhizobium,* adopting the generic name suggested by Frank.§ This classification is based mainly on form, but cultural characteristics have since been ascribed to several of these forms.

Byerinck made numerous artificial cultures and claims** that different races were obtained which remained true to form through successive cultures.

Nobbe, Schmid, Hiltner and Hotter†† found that "*Lupinus luteus* inoculated with pea tubercle organisms, as well as those from Robinia, Cytisus and Gleditschia, developed no tubercles, but when inoculated with lupine tubercle organisms, developed tubercles. *Phaseolus vulgaris* inoculated with cultures from tubercles of Phaseolus and peas developed tubercles, but if inoculated with cultures from tubercles of Lupinus or Robinia none were developed. In one case *Pisum sativum* inoculated

*Landw. Vers. Stat. 39, 227-359 (1893).

†Ag. Sci. 7: 58, (1893).

‡Bul. Torrey Bot. Club XIX 203, July 1892.

§Ueber die Pilzesymbiose der Leguminosen, Berlin 1890.

**Bot. Zeit. 1888; cited by Atkinson, Bot. Gaz. 18: 262.

††Landw. Versuchs Stat. XXXIX (1891), 227-359.

with lupine tubercle organisms developed tubercles, while in other cases it did not."*

Laurent† found that he could produce tubercles on the roots of the pea, by inoculating from the tubercles of any one of thirty-six different species of leguminous plants. All species, however, would not produce them in equal numbers. From these and other studies he believed that there are many varieties of the organism associated with the different species of legumes. It was found, however, that ordinary soil bacteria have no power to produce tubercles.

Atkinson inoculated young plants of *Dolichos sinensis* with organisms from *Vicia sativa* without effect, while inoculated plants of Vicia from the same culture produced tubercles. Considering the almost universal infection of leguminous plants, however, he doubts whether there are so many species as are represented by the different forms of bacteroids and suggests a possible influence of the various plants on which the different forms are found. "Does not the influence of the macrosymbiont upon the microsymbiont while within the tubercle fix a certain type of racial form and attenuation upon the microsymbiont until it shall have passed through normal conditions in the soil again and been restored to its original form and infecting power?"‡ The question as yet remains open.

FIXATION OF NITROGEN BY NON-LEGUMINOUS PLANTS.

Some non-leguminous plants possess well developed root tubercles, the function of which is, in many cases, uncertain. Among such is *Elaeagnus angustifolius.* This plant, as shown by Nobbe and others§ is without doubt able through its root tubercles, to assimilate the free nitrogen of the air. These tubercles are produced by an organism entirely distinct from *Bacterium radicicola.* In demonstrating this power of assimilation in Elaeagnus, Nobbe planted some Elaeagnus seedlings in pots containing sterilized nitrogen-free sand. The sand in one pot was then inoculated with an extract of soil in which Elaeagnus had grown. No marked result was noticeable the first

*Cited by Atkinson, Bot. Gaz. 18: 263.

†Ann. d. L'Inst. Pasteur, 1891, No. 2.

‡Atkinson, Bot. Gaz. 18: 263. (1893).

§Landw. Vers. Stat. 41, pp. 138-140.

season, but the following year the plant from the inoculated pot made a vigorous growth and branched freely, while uninoculated plants were without branches and in a famished condition.

Experiments by Breal,* Frank,† and others indicate that some other non-leguminous crops—including oats, barley, rape, spurry and cresses—may utilize a certain amount of atmospheric nitrogen. In Breal's experiments, cress seeds were germinated on moist filter paper and then transferred to flower pots containing sand. The pots were moistened with a nutritive solution containing all the essential elements of plant food except nitrogen. The plants developed slowly at first but afterward made normal growth and produced seeds. A determination of the amount of nitrogen in sand at the beginning and the end of the experiment, as also that in the water used and in the plants, was made. It was found that the plants produced, contained much more nitrogen than the seed and the water used.

That the gain above noted was due to micro-organisms was shown by a duplicate lot in which both the sand and the seeds used were sterilized. "The plants in sterilized soil grew normally at first but after reaching a height of about 0.14 meter produced a few imperfect seeds and began to languish."

From the data presented it was concluded:

1. "A soil very poor in nitrogenous matter planted with cresses (Breal) or with various phanerogamous or cryptogamous plants (Frank) is capable of bringing these plants to maturity.

2. "The nitrogen used is not entirely derived from the soil, since it appears that in some cases the soil is enriched instead of impoverished by the gain of the plant, and in cases where loss does occur it is overbalanced by the gain by the plant."‡

In a résumé of his experiments in 1892§ Frank referred to two experiments with non-leguminous phanerogams—mustard and potato. The results were as follows:¶

Sinapis alba (4 plants)—grams of nitrogen in seed 0.0012; in crop, 0.0043.

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*Ann. Agronom. 18 (1892), No 8, pp. 269-379.

†Deut. Landw. Presse, 1891, p. 779.

‡Abstract of Breal's paper, Ex. Sta. Record IV, 376.

§Bot. Ztg. 51: 150 *et. seq.*

¶Cited by Russell, Bot. Gaz. XIX, 286.

Solanum tuberosum (4 pcs.)—grams of nitrogen in seed 0.022; in crop, 0.2186.

Another experiment with *Sinapis alba* detailed in the same paper, also indicated a certain amount of nitrogen fixed. These results with mustard were apparently confirmed by Liebscher,* but in both cases the methods of analysis were lacking in accuracy and the factors of growth were not carefully controlled.

Lotsy† in 1893, after a very careful study of the subject, using both sand and water cultures in sterilized and unsterilized conditions, asserts positively that neither *Sinapis alba* nor *S. nigra* are able to live without combined nitrogen. Schloesing and Laurent have also shown‡ that white mustard, oats, cress and spergula were unable to assimilate free nitrogen.

In 1890, Petermann§ announced that barley was as efficient as beans in collecting nitrogen. After repeating his experiments, however, under more careful control, he was obliged to retract.¶

In 1893, Frank,** in summarizing the results of his experiments, repeated his assertion that, "the non-leguminous organisms can assimilate free nitrogen," and cites examples of fungi, algae and mosses, as well as oats, buckwheat, spurry, turnip, white mustard, potato and maple.

Nobbe and Hiltner†† conducted a series of experiments with mustard. The plants were grown in sand to which varying amounts of nitrogen were added from time to time. The total yield of nitrogen kept pace with the varying amounts of soil nitrogen, but there was no increase due to assimilation of free nitrogen.

In another experiment‡‡ with peas, mustard, buckwheat, and oats, it was found that the peas alone were able to acquire the nitrogen of the air, while the others showed a decline in spite of the increased amount of nitrogen in the soil.

Frank's discovery that certain algae are able to utilize uncombined nitrogen has been repeatedly confirmed by Schloesing

*Jour. f Landw. 41: 180 (1893).
†Bul. 18, O. E. S., U. S. Dept. of Agr.
‡Ann. Inst. Past. 6: 114 (1892).
§Mem. Acad. Roy. de Belg. 44: 1889.
¶Bul. Acad. Roy. de Belg. 25: 267-276, 1893.
**Bot. Ztg. 51: 139 (1893).
††Landw. Vers. Stat. 45 (1894), 155-159.
‡‡*Ibid.*

and Laurent* as well as by Koch and Kossowitsch† and others. This fact of assimilation of algae, long overlooked, is of the greatest importance in harmonizing the results of various investigators in studying non-leguminous plants where the amount of nitrogen claimed to be assimilated is always small.

SOIL INOCULATION.

Some of the most valuable work in the inoculation of soils with tubercle bacilli is that of Nobbe‡ and others at Tharand, Saxony. In these experiments peas, lupines, beans, common locust (*Robinia pseudacacia*), honey locust (*Gleditschia triacanthos*) and Laburnum (*Cytisus Laburnum*,) were used. Both pure cultures of bacteria, prepared from the tubercles of each species, and extracts of soil in which each of the above mentioned plants had previously grown were employed.

It was found that the extracts of different soils are quite different in their action on different plants. Nearly all the plants inoculated produced tubercles, but in varying numbers, and the tubercles were confined almost exclusively to those roots near the surface.

One very interesting fact in this connection is that where the inoculation of Robinia was successful the amount of dry matter produced and the percentage of nitrogen in the same, were larger than when the plants received a dressing of nitrogenous fertilizers instead. The results obtained from these experiments will be referred to more in detail hereafter.

Lawes and Gilbert, in 1888, carried on extensive experiments with peas, beans, vetches, lupines, white and red clover, sainfoin and lucern. Plants were grown in sterilized soil; also in rich garden soil to which a watery extract from soils which had previously grown each of the various crops under study, was applied. Favorable results were obtained and the next year the work was repeated. It was found that without the "microbe-seeding," nodules were not formed and there was no gain of nitrogen; but when the microbes were added, there was nodule formation and, co-incidently, considerable gain of nitrogen.

*Compt. rend. 115; 732 (1892).

†Bot. Ztg. 51; 342 (1893).

‡Landw. Vers. Stat. 39, pp. 327–359.

In the sand, the infection was comparatively limited, though some of the nodules developed to great size. In the rich soil the infection was more general and the nodules, though more numerous were much smaller.

Some of the most careful work done in this direction is that of Hellriegel and Wilfarth* at Bernburg, Germany. In the pot experiments made, it was found that when the soil was not sterilized the leguminous plants had tubercles on the roots and there was a noticeable acquisition of nitrogen. When the soil was kept sterile, the plants grew only in proportion to the nitrogen in the soil; the roots had no tubercles and there was no evidence of acquisition of atmospheric nitrogen.

In the field experiments at Bernburg, the fact that different species of leguminous plants require different kinds of tubercle-bacteria was well shown.

Nobbe, Schmid, Hiltner and Hotter, having observed† that when soils were inoculated at the surface, only the upper part of the root system produced tubercles, undertook to determine the reason for this.‡ Some pea plants were set in sterilized sand and supplied only with mineral manures. After forty-one days there were marked evidences of a lack of nitrogen and the soil was inoculated to a depth of 200 mm. with an emulsion of pure cultivated pea-tubercle bacteria. The effect of the inoculation was soon apparent. Within three weeks the plants took on a dark green color and developed rapidly. On harvesting it was observed that only those roots in close proximity to the point of inoculation had produced tubercles, showing the inability of the bacteria to spread to any considerable extent in the soil. The experiment was repeated with like results. "It appears that the distribution of tubercles on the roots is determined by the presence of active bacteria in the soil at the proper place and time."

Schmitter, in Germany, found marked results from the inoculation of clay soils with bacteria from the root tubercles of lupines. On cultivated soils results were negative, but on soils previously uncultivated the increase in the weight of the lupine plants was from 11 to 32 per cent.§

*Résumé by Wilfarth, Ex. Sta. Record III, 334 (1891).

†Landw. Vers. Stat. 39, pp. 327–359.

‡Landw. Vers. Stat. 41, pp. 137, 138.

§Bot. Centbl. 57 (1894), No. 1, pp. 25, 26.

Jaspers* cites a statement by Von Landsberg, that the lupine thrives without inoculation on land which has grown broom (*Sarothamas scoparius.*) He thinks that the organism causing root tubercles may sink deep into the soil and retain its vitality for a long time. In proof of this theory he cites the observation that lupines flourished even at the bottom of deep cuts along the railroad.

This position is directly contrary to that before expressed, viz.: That the bacteria are diffused but slightly through the soil.

PRACTICAL APPLICATIONS.

Soil inoculation may be accomplished either by distributing some material containing the specific germs over the soil or by bringing the seeds in contact with the germs before planting; thus assuring the presence of bacteria when the roots first start. The material used may be either soil in which leguminous plants of the same or a closely related kind have previously been grown; or tubercles from such plants; or it may be a pure culture in gelatin of the specific bacteria required.

The prepared culture, sold as Nitragin or Germ Fertilizer is made in Germany and may be obtained of Victor Koechl & Co., 79 Murray Street, New York. Cultures for pea, clover, vetch and various other legumes are made.

Our experience at the Experiment Station in the inoculation of soils with specific bacteria has been limited, but in the case of the soja bean decided results were obtained.

Until the present season soja beans were never grown in the station garden, therefore it was safe to assume that none of the bacteria peculiar to the plant were present in the soil.

June 14, a quantity of soja beans was planted in drills and with the seed a number of tubercles from the previous year's crop at the Storrs Experiment Station, were scattered. In contiguous rows, the same variety of bean was planted without tubercles. The crop was cut by frost before maturity so no weights were obtained, but on October 14, the following results were noted:

1. The plants from the inoculated soil were more stocky and of a darker color than those from the adjacent rows.

*Deut. landw. Presse. 22 (1895), No. 28, p. 266.

2. The plants from the inoculated soil bore an abundant supply of tubercles while the others bore *none*.

3. The average height of plants from inoculated soil was 2 feet 2 inches; from the other plot, 1 foot 11 inches.

4. The average number of pods per plant from inoculated soil was 81, from the other plot 74.

Our results are confirmed and emphasized by the experience of Professor J. F. Duggar of the Alabama Experiment Station. In his work with the hairy vetch (*Vicia villosa*), Duggar found that plants from seed dipped in water into which there had been stirred earth in which the common vetch had formerly grown, were vastly superior to those from seed not treated. "With inoculation the yield was over ten times as great as without inoculation, the increase in hay being 995 per cent.*

A Trial of Nitragin—In April, the W. H. Bowker Fertilizer Company sent a bottle of nitragin for the common pea for trial. The material was used in accordance with the directions sent, i. e., the nitragin was warmed and diluted with water after which it was poured over the seed and allowed to stand for an hour. The peas were then planted in the field and in adjacent rows seeds not treated were planted.

There was no appreciable effect from the inoculation. Tubercles developed abundantly on both lots, a result which is not strange, since peas have been grown freely in the vicinity for many years and the necessary germs have been carried by the wind in all directions.

A series of green-house experiments conducted by Duggar† at the Alabama Experiment Station yielded very different results from our own and indicate that on some soils nitragin may give a very marked increase in the yields of leguminous plants.

Duggar's work included experiments with hairy vetch, Canada field peas, and crimson clover, and it was found that in each case the yield was greatly increased as a result of the inoculation.

"The increase in weight of inoculated plants after thoroughly drying was as follows:

*Bul. 87 Alabama Expt. Sta. 466.

†l. c.

"Hairy vetch increased by 89 per cent.

"Canada field peas increased by 138 per cent.

"Crimson clover (young plants) increased by 146 per cent.

"Germ fertilizer prepared for vetch was effective on Canada field peas."

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DIGESTION EXPERIMENTS.

J. M. Bartlett.

The digestibility of the following materials has been determined during the past year:

Silage—Made of mature flint corn, sunflower heads and horse beans.

Silage—Made of mature flint corn, sunflowers (whole plant) and horse beans.

Silage—Made of Sanford corn, a large white flint variety.

Hay, mostly timothy.

Corn meal.

Skimmed milk.

The animals used were sheep (wethers), from five to seven years old, of medium size and in good condition. No. 1 was slightly larger and more vigorous than the other two and he also had a better appetite, with perhaps stronger digestive powers, which may account for his giving higher digestive coefficients when heavily fed. No. 2, when fed a ration of hay alone, refused to eat but a small quantity and it would seem that his dislike for the food affected his digestion, as he gave a very low coefficient for protein. They all stood the confinement well and as a rule ate their rations up clean.

The experiments were conducted on the plan which has been followed in the past by the Station. The feeding periods were twelve days each; the first seven days being used as preliminary feeding, and the last five days for the experiment, during which time the feces were collected and weighed. The rations were uniform for each animal and weighed throughout the whole feeding period.

In connection with these digestion experiments the heats of combustion of the feeding stuffs and the feces were determined by the use of the bomb calorimeter. The method followed in the calculations is that of Atwater and Woods given on pages 123 and following in the report of the Storrs (Conn.) Experiment Station, for 1894.

The composition of the feeding stuffs used in these experiments is given in the table which follows:

COMPOSITION OF FODDERS AND FEEDING STUFFS USED IN DIGESTION EXPERIMENTS IN 1896-7.

	Station number.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%
Silage (mature corn, sunflower heads, and horse beans)	4045	79.85	1.70	2.72	5.00	9.99	0.74
Silage (mature corn, sunflower, whole plant, and horse beans)	4046	80.90	1.67	2.31	4.83	9.62	0.67
Silage (Sanford corn, partially mature	4048	81.50	1.27	1.80	4.90	9.97	0.56
Hay, mostly timothy...........	4061	16.50	4.92	7.91	26.57	42.33	1.77
Corn meal	4062	14.84	1.71	10.31	1.67	68.43	3.04
Skimmed milk	4075	90.50	0.75	3.56	....	5.07	0.12

COMPOSITION OF FODDERS AND FEEDING STUFFS USED IN DIGESTION EXPERIMENTS IN 1896-7 CALCULATED TO WATER-FREE SUBSTANCE.

	Station number.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%
Silage (mature corn, sunflower heads, horse beans)	4045	8.44	13.50	24.81	49.60	3.65
Silage (mature corn, sunflowers, whole plant, and horse beans)...............	4046	8.73	12.09	25.27	50.40	3.51
Silage (Sanford corn, partially matured)	4048	6.90	9.72	26.45	53.90	3.03
Hay, mostly timothy..	4061	5.89	9.47	31.82	50.70	2.12
Corn meal	4062	2.00	12.10	1.96	80.37	3.57
Skimmed milk	4075	7.85	37.50	....	53.37	1 28

DIGESTION EXPERIMENT 56—(MIXED SILAGE.)

Material used: Silage made of mature flint corn, horse beans and sunflower heads, cut and put in the silo in the proportion of one acre of corn, one-fourth acre of sunflower heads and one-half acre of horse beans. This mixture was first recommended by Professor Robertson of Canada, and so far as the writer is aware, this is the first digestion experiment that has ever been made with it. The material was perfectly preserved in the silo and readily eaten by the sheep. The results of the experiment are given in the following tables:

RATIONS.

Fed daily, Sheep I, 3,000 grams.
Fed daily, Sheep II, 2,500 grams.

COMPOSITION OF FODDER AND FECES.

	Lab. number.	Dry matter.	Water-free. Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
Fodders.		%	%	%	%	%	%	%	
Silage (corn, sunflower heads, horse beans)..	4045	20.15	91.56	8.44	13.50	24.81	49.60	3.65	4370
Feces.									
Sheep I.	4049	....	84.69	15.31	14.60	27.73	39.84	2.52	4415
Sheep II	4050	....	86.34	13.66	14.62	29.49	39.70	2.53	4425

FUEL VALUE OF FOOD FOR 5 DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I.	13208.	4328	8880	231	8649	65.5
Sheep II............	11007	4073	6934	179	6755	61.4
Average						63.5

TOTAL NUTRIENTS IN THE FODDER EATEN AND FECES EXCRETED IN FIVE DAYS.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep I:	Grams.	Grams.	Grams	Grams	Grams	Grams.	Grams
Silage	3022.5	2767.3	255.1	408.1	749.6	1499.2	110.4
Feces	980.2	830.1	150.1	143.1	271.8	390.5	24.7
Digested	2042.3	1937.2	105.0	265.0	477.8	1108.7	85.7
Per cent digested	67.6	70.0	41.2	64.9	63.7	74.0	77.6
Sheep II:							
Silage	2518.8	2306.2	212.6	340.0	624.7	1249.4	92.1
Feces	920.5	794.8	125.7	134.6	271.5	365.4	23.3
Digested	1598.3	1511.4	86.9	205.4	353.2	884.0	68.8
Per cent digested	63.5	65.6	40.9	60.4	56.5	70.8	74.7
Average per cent digested	65.6	67.8	41.1	62.7	60.1	72.4	76.7

DIGESTION EXPERIMENT 57—(MIXED SILAGE.)

Material used: Silage made of mature flint corn, horse beans and sunflowers (whole plant), cut and put in the silo in the proportion of one acre of corn, one-fourth acre sunflowers and one-half acre horse beans. This mixture was well preserved and notwithstanding the coarse nature of the sunflower stalks was readily eaten by the sheep, not enough being left to affect the results.

RATIONS.

Fed daily, Sheep I, 3,000 grams; Sheep II, 2,500 grams.

COMPOSITION OF FODDER AND FECES.

	Laboratory number.	Dry matter.	Water-Free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDERS.		%	%	%	%	%	%	%	
Silage (corn, sunflowers, horse beans)	4046	19.10	91.27	8.73	12.09	25.27	5.04	3.51	4334
FECES.									
Sheep I	4051	......	80.91	19.09	14.44	25.82	38.33	2.32	4215
Sheep II	4052	......	81.46	18.54	15.03	24.90	38.55	2.98	4205

TOTAL NUTRIENTS IN THE FODDER EATEN AND FECES EXCRETED IN FIVE DAYS.

MATERIALS.	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep I.	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Silage	2864.0	2614.0	250.0	346.3	723.7	1443.5	100.5
Feces	1041.3	842.5	198.8	150.4	268.9	399.1	24.1
Digested	1822.7	1771.5	51.2	195.9	454.8	1044.4	76.4
Per cent digested	63.6	67.8	20.5	56.6	62.8	72.4	76.0
Sheep II.							
Silage	2378.5	2170.9	207.6	287.5	601.1	1198.8	83.5
Feces	776.9	632.9	144.0	116.8	193.4	299.5	23.2
Digested	1601.6	1538.0	63.6	170.7	407.7	899.3	60.3
Per cent digested	67.3	70.8	30.6	59.3	67.8	75.0	72.2
Average	65.5	69.3	25.6	58.0	65.3	73.7	74.1

FUEL VALUE OF FOOD FOR 5 DAYS AS DETERMINED BY THE BOMB CALORIMETER.

EXPERIMENT II.	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	12,413	4389	8024	170	7854	63.3
Sheep II	10,308	3267	7041	149	6892	66.9
Average	....	....	....	....	....	65.1

DIGESTION EXPERIMENT 58—(CORN SILAGE.)

Material used: Silage made from Sanford corn, a large white flint variety but recently grown in this section. An enormous crop was produced in 1896 which was only partially matured, only a part of the ears being glazed. Although this silage was well preserved and in good condition, Sheep No. II refused to eat it, consequently two trials were made with Sheep I.

The results are given in the following tables:

RATIONS.

Fed daily, Sheep I, 3,000 grams.

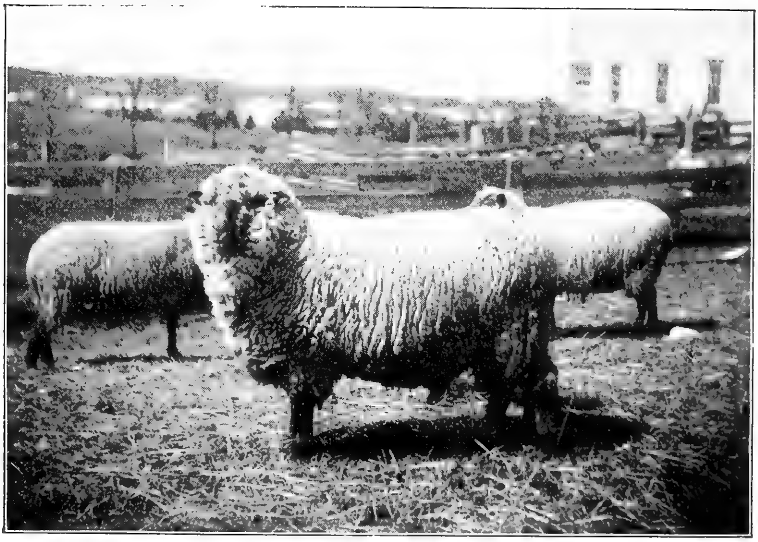
COMPOSITION OF FODDERS AND FECES.

	Lab. number.	Dry matter.	Water-free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDERS.		%	%	%	%	%	%	%	
Silage, Sanford corn.	4048	18.57	9.31	6.9	9.72	26.45	53.9	3.03	42.34
FECES.									
Sheep I	4053	-	84.52	15.48	13.84	27.34	43.74	2.60	43.81
Sheep II	4054	-	85.44	14.56	14.36	24.78	43.44	2.86	44.26

TOTAL NUTRIENTS IN THE FODDER EATEN AND FECES EXCRETED IN FIVE DAYS AND PER CENTS DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Silage	2775.0	2583.5	191.5	269.7	734.0	1495.7	84.1
Feces	846.7	715.6	131.1	117.2	206.1	370.3	22.0
Digested	1928.3	1867.9	60.4	152.5	527.9	1125.4	62.1
Per cent digested	69.5	72.3	31.5	56.5	71.9	75.2	73.8
SHEEP I.							
Silage	2775.0	2583.5	191.5	269.7	734.0	1495.7	84.1
Feces	824.9	704.8	120.1	118.4	204.4	358.4	23.6
Digested	1950.1	1878.7	71.4	151.3	529.6	1137.3	60.5
Per cent digested	70.3	72.7	37.3	56.1	72.2	76.0	71.9
Average	69.9	72.5	34.4	56.3	72.1	75.6	72.9

DORSET HORN BUCK.



SHROPSHIRE BUCK.

FUEL VALUE OF FOOD FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

EXPERIMENT III.	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	10769	3366	7403	133	7270	67.5
Sheep I	10769	3306	7463	132	7331	68.1
Average	-	-	-	-	-	67.8

DIGESTION EXPERIMENT 59—(HAY.)

Material used: Hay, mostly timothy.

The object of this experiment was to determine the digestibility of hay which was to be fed with corn meal and skimmed milk in the next three experiments.

The results are presented below:

RATIONS.

Fed daily, Sheep I, 600 grams.
Fed daily, Sheep II, 400 grams.
Fed daily, Sheep III, 600 grams.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	WATER-FREE.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDERS.		%	%	%	%	%	%	%	
Hay	4061	83.5	94.11	5.89	9.47	31.82	50.70	2.12	4867
FECES.									
Sheep I	4055	-	89.81	10.19	11.51	33.47	41.81	3.02	4694
Sheep II	4056	-	90.36	9.64	12.61	32.35	42.43	2.98	4711
Sheep III	4057	-	91.39	8.61	10.98	34.73	43.12	2.56	4694

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
SHEEP I.							
Hay	2505	2357.5	147.5	237.3	797.1	1270.0	53.1
Feces	1070	961.0	109.0	123.2	358.1	447.4	32.3
Digested	1435	1396.5	38.5	114.1	439	822.6	20.8
Per cent digested	57.3	59.2	26.1	48.1	55.1	64.8	39.2
SHEEP II.							
Hay	167.0	1571.6	98.4	158.1	531.4	846.7	35.4
Feces	766.9	693.0	73.9	96.7	248.1	325.3	22.9
Digested	903.1	878.6	24.5	61.4	283.3	521.4	12.5
Per cent digested	54.1	56.9	24.9	38.8	53.3	61.6	35.3
SHEEP III.							
Hay	2505	2357.5	147.5	237.3	791.1	1270.0	53.1
Feces	1160.6	1060.7	99.9	127.4	403.1	500.5	29.7
Digested	1344.4	1296.8	47.6	109.9	388.0	769.5	23.4
Per cent digested	53.7	55.0	32.3	46.3	49.0	60.6	44.1
Average	55.0	57.0	27.8	44.4	52.5	62.3	38.9

FUEL VALUE OF FOOD FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

Experiment IV.	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	12191	5023	7168	99	7069	57.9
Sheep II	7821	3613	4208	53	4155	53.1
Sheep III	12191	5448	6743	96	6647	54.5
Average	-	-	-	-	-	55.2

DIGESTION EXPERIMENT 60—(CORN MEAL.)

Material fed: Hay and corn meal.

The object of this experiment was to determine the digestibility of the protein of corn meal. The American coefficient for protein is much less than the German and about 25% less than that of gluten meal, which is a residue of corn left in the manufacture of glucose and starch. One would expect, therefore, protein of corn and gluten meals to have about the same digestibility, unless the carbohydrates which are removed in the manufacture of gluten meals protect the protein from the action of digestion fluids, which supposition is hardly probable. It is most likely that the large difference noted is due to metabolic nitrogen of the feces, which would introduce a much greater error in the case of a feed low in protein, like corn meal, than in the case of a feed higher in protein, like gluten meal. It is necessary to feed a coarse fodder like hay with a fine feed like corn meal in order to keep the animal in normal condition. The digestibility of the hay used was determined in the preceeding experiment and in calculating the digestibility of the corn meal, the individual coefficients of each sheep obtained for the hay was used instead of an average of them.

The detailed results are given in the following tables:

RATIONS.

Fed daily each sheep, hay, 400 grams; corn meal, 300 grams.

COMPOSITION OF FOOD AND FECES.

	Laboratory number.	Dry matter.	Water-free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
		%	%	%	%	%	%	%	
FODDERS.									
Hay	4061	83.5	94.11	5.89	9.47	31.82	50 7	2.12	4867
Corn meal	–	85.6	98.00	2.00	12.10	1.96	80.37	3.57	–
FECES.									
Sheep I	4058	–	88.81	11.19	15.51	28.36	41.70	3.24	4694
Sheep II	4059	–	90.64	9.36	15.33	28.85	43.44	3.02	4699
Sheep III	4060	–	91.33	8.67	13.02	33.48	42.14	2.69	4820

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED FOR FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
SHEEP I.							
Fed in hay	1670	1571.6	98.4	158.1	531.4	846.7	35.4
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	2947.4	2823.5	123.9	312.7	556.4	1873.4	81.0
Total feces	749.8	665.9	83.9	116.3	212.7	312.6	24.3
Total digested	2197.6	2157.6	40.0	196.4	343.7	1560.8	56.7
Digested from hay	956.6	930.9	25.7	76.0	-	548.4	13.9
Digested from corn meal	1241.0	1226.7	14.3	120.4	-	1012.4	42.8
Per cent digested from corn meal	97.1	98.0	56.1	77.8	-	98.6	93.8
SHEEP II.							
Fed in hay	1670.0	1571.6	98.4	158.1	531.4	846.7	35.4
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	2947.4	2823.5	123.9	312.7	556.4	1873.4	81.0
Total feces	847.7	768.4	79.3	129.9	244.6	368.3	26.6
Total digested	2099.7	2055.1	44.6	182.8	311.8	1505.1	55.4
Digested from hay	903.1	878.6	24.5	61.4	-	521.4	12.5
Digested from corn meal	1196.6	1176.5	20.1	121.4	-	983.7	42.9
Per cent digested from corn meal	93.7	93.9	78.8	78.5	-	95.8	94.1
SHEEP III.							
Fed in hay	1670.0	1571.6	98.4	158 1	531.4	846.7	35.4
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	2947.6	2823.5	123.9	312.7	556.4	1873.4	81.0
Total feces	911.8	832.7	79.1	118.7	305.3	384.2	24.5
Total digested	2035.8	1990.8	44.8	194.0	251.1	1489.2	56.5
Digested from hay	896.3	864.5	31.8	73.2	-	513.0	15.6
Digested from corn meal	1139.5	1126.5	13.0	120.8	-	976.2	40.9
Per cent digested from corn meal	89.2	89.9	50.9	79.7	-	95.1	89.7
Corn meal average	93.3	93.6	61.9	78.7	-	98.5	92.5

DIGESTION EXPERIMENT 61—(SKIMMED MILK.)

Material used: Hay and skimmed milk.

This experiment was made to determine the digestibility of skimmed milk which was to be used as a source of digestible protein in further experiments with corn meal. In nearly all digestion experiments with human subjects the protein of milk has been assumed to be wholly or at least 98 per cent digestible, and it was expected that figures agreeing quite closely with those would be obtained with sheep. It will be seen by the tables that the results of the experiment give figures considerably below the assumed digestibility and probably much lower than they should be, due to the error introduced by the presence of metabolic nitrogen in the feces. The corrected results given in tables on page 155 are probably more nearly correct.

It will be observed also that the organic matter is about one hundred per cent digestible, which makes the figures for protein appear more inconsistant.

RATIONS.

Fed daily each sheep, hay, 400 grams; milk, 3,500 grams.

NOTE—Sheep No. II took but 200 grams of hay per day.

COMPOSITION OF FOOD AND FECES.

	Laboratory number.	Dry matter.	Water-free.					
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
FODDERS.		%	%	%	%	%	%	%
Hay	4061	83.50	94.11	5.89	9.47	31.82	50.70	2.12
Skimmed milk	4075	9.50	92.15	7.85	37.50	-	53.37	1.28
FECES.								
Sheep I	4068	–	81.78	18.22	15.88	24.07	39.26	2.57
Sheep II	4069	–	77.80	22.2	20.15	19.78	35.99	1.88
Sheep III	4070	–	86.43	13.57	14.70	27.22	42.10	2.41

TOTAL NUTRIENTS IN HAY EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
SHEEP I.							
Fed in hay	1670.0	1571.6	98.4	158.1	531.4	846.7	35.4
Fed in skimmed milk	1649.0	1518.8	130.2	617.9	-	880.1	20.8
Total fed	3319.0	3090.4	228.6	776.0	531.4	1726.8	56.2
Total feces	783.7	640.9	142.8	124.5	188.6	307.7	20.1
Total digested	2535.3	2449.5	85.8	651.5	342.8	1419.1	36.1
Digested from hay	956.6	930.9	25.7	76.0	292.6	548.4	13.9
Digested from skimmed milk	1578.7	1518.6	60.1	575.5	-	870.7	22.2
Per cent digested from skimmed milk	95.7	99.9	46.1	93.1	-	98.9	106.7
SHEEP II.							
Fed in hay	835.0	785.8	49.2	79.0	265.7	423.4	17.7
Fed in skimmed milk	1653.8	1523.2	130.6	619.7	-	882.6	20.9
Total fed	2488.8	2309.0	179.8	698.7	265.7	1306.0	38.6
Total from feces	450.5	350.5	100.0	90.8	89.1	162.1	8.5
Total digested	2038.3	1958.5	79.8	607.9	176.6	1143.9	30.1
Digested from hay	451.6	439.3	12.3	30.7	141.6	260.7	6.3
Digested from skimmed milk	1586.7	1519.2	67.5	577.2	-	883.2	23.8
Per cent digested from skimmed milk	95.9	99.8	51.7	93.1	-	100.4	113.9
SHEEP III.							
Fed in hay	1670	1571.6	98.4	158.1	531.4	846.7	35.4
Fed in skimmed milk	1655.4	1524.6	130.8	620.7	-	884.0	20.9
Total fed	3525.4	3096.2	229.2	778.8	531.4	1730.7	56.3
Total from feces	740.7	640.2	100.5	108.9	201.6	311.8	17.9
Total digested	2584.7	2456.0	128.7	669.9	329.8	1418.9	38.4
Digested from hay	896.8	864.4	31.8	73.2	262.7	513.0	15.6
Digested from skimmed milk	1687.9	1591.6	96.9	596.7	-	905.9	22.8
Per cent digested from skimmed milk	101.9	104.4	74.1	96.13	-	102.5	109.1

DIGESTION EXPERIMENT 62—(CORN MEAL.)

Materials used: Hay, skimmed milk, corn meal.

This experiment was undertaken to determine the effect of feeding a large amount of digestible protein, on the digestibility of corn meal.

The results with the different animals are not as close as is desirable, but the average coefficient for protein agrees very well with the average obtained in Experiment VI. It is possible that the ration fed was a little too heavy, especially for sheep 3, hence the low digestion coefficient obtained. The coefficients obtained in experiments VI and VII were used in calculating the digestibility of the hay and milk.

RATIONS.

Fed daily each sheep, hay, 300 grams; milk, 3,500 grams; corn meal, 300 grams.

COMPOSITION OF FODDERS AND FECES.

			Water-free.					
	Lab. number.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fodders:		%	%	%	%	%	%	%
Hay	4061	83.50	94.11	5.89	9.47	31.82	50.70	2.12
Skimmed milk	4075	9.50	92.15	7.85	37.50	....	53.37	1.28
Corn meal	4062	85.16	98.00	2.00	12.10	1.96	80.37	3.57
Feces:								
Sheep I	4071	....	81.39	18.61	18.45	21.84	38.66	2.44
Sheep II	4072	....	80.85	19.15	20.22	20.90	37.36	2.37
Sheep III	4073	....	85.00	15.00	17.13	26.30	39.65	1.92

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED FOR FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Fed in hay	1252.5	1178.7	73.8	118.5	398.6	635.0	26.6
Fed in skimmed milk	1662.5	1531.3	131.2	623.0	–	887.3	21.0
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	4192.4	3961.9	230.5	896.1	423.6	2549.0	93.2
Total in feces	704.9	573.7	131.2	130.0	154.0	272.5	17.2
Total digested	3487.5	3388.2	99.3	766.1	269.6	2276.5	76.0
Digested from hay and skimmed milk	2308.7	2231.1	79.8	637.0	–	1289.0	31.4
Digested from corn meal	1178.8	1157.1	19.5	129.0	–	987.5	44.6
Per cent digested from corn meal	92.3	92.4	76.4	83.4	–	96.2	97.8
SHEEP II.							
Fed in hay	1134.8	1068.0	66.8	107.5	361.1	575.3	24.1
Fed in skimmed milk	1662.5	1531.3	131.2	623.0	–	887.3	21.0
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	4074.7	3851.2	223.5	885.1	386.1	2489.3	90.7
Total feces	699.0	565.1	133.9	141.3	146.1	261.1	16.6
Total digested	3375.7	3286.1	89.6	742.8	240.0	2228.2	74.1
Digested from hay and skimmed milk	2208.2	2140.1	84.5	620.8	–	1241.7	29.6
Digested from corn meal	1167.5	1146.1	5.1	122.0	–	986.5	44.5
Per cent digested from corn meal	91.4	91.6	20.0	78.9	–	96.1	97.6
SHEEP III.							
Fed in hay	1252.5	1178.7	73.8	118.5	398.6	635.0	26.6
Fed in skimmed milk	1662.5	1531.3	131.2	623.0	–	887.3	21.0
Fed in corn meal	1277.4	1251.9	25.5	154.6	25.0	1026.7	45.6
Total fed	4192.4	3961.9	230.5	896.1	423.6	2549.0	93.2
Total in feces	800.2	680.2	120.0	137.1	210.4	317.3	15.4
Total digested	3392.2	3281.7	110.5	759.0	213.2	2231.7	77.8
Digested from hay and skimmed milk	2325.1	2179.6	97.2	653.5	–	1272.1	32.7
Digested from corn meal	1067.1	1102.1	13.2	105.5	–	959.6	45.1
Per cent digested from corn meal	85.1	88.0	52.1	68.3	–	93.5	98.9
Average	98.6	90.7	49.5	76.9	–	95.3	98.1

SUMMARY OF DIGESTION COEFFICIENTS OBTAINED IN THE EXPERIMENTS HERE REPORTED.

	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%	%	%	%
Silage, mature flint corn, sunflower heads and horse beans	65.6	67.8	41.1	62.7	60.1	72.4	76.7
Silage, mature flint corn, sunflowers, whole plant, and horse beans	65.5	69.5	25.6	58.0	65.3	73.7	74.1
Silage, Sanford corn, partially mature	69.9	72.5	34.4	56.3	72.1	75.6	72.9
Hay, mostly timothy	55.0	57.0	27.8	44.4	52.5	62.3	38.9
Skimmed milk							
Corn meal (fed with hay)	93.3	93.6	61.9	78.7	......	98.5	92.5
Corn meal (fed with hay and skimmed milk)	89.6	90.7	49.5	76.9	......	95.3	98.1

DIGESTION COEFFICIENTS OBTAINED FOR PROTEIN AFTER CORRECTION FOR METABOLIC NITROGEN.

	Sheep.	Total protein in feces.	Protein Left After Treatment with: Pepsin, H Cl solution.	Protein Left After Treatment with: Alcohol, ether, water and lime water.	Coefficents After Treatment with: Pepsin, H Cl solution.	Coefficents After Treatment with: Alcohol, ether, water and lime water.
		grams.	grams.	grams.	%	%
Hay (mostly timothy)	I	123.2	80.4	84.1	66.1	64.6
	II	96.7	67.0	71.7	57.7	54.6
	III	127.4	84.6	77.4	64.4	67.5
Average		....	....	....	62.7	62.2
Corn meal (fed with hay)	I	116.3	77.7	70.9	84.4	90.4
	II	124.9	82.9	84.0	89.4	92.1
	III	118.7	77.2	68.3	86.5	89.1
Average		....	....	....	86.8	90.5
Skimmed milk (fed with hay)	I	124.5	81.0	73.9	95.6	97.1
	II	90.8	55.1	53.8	96.5	97.1
	III	108.9	74.2	61.2	97.1	98.4
Average		....	....	....	96.4	97.5
Corn meal (fed with hay, and skimmed milk)	I	130.0	80.8	71.4	91.6	92.6
	II	141.3	89.3	76.6	85.8	93.7
	III	137.1	91.6	74.7	79.7	83.1
Average		....	....	....	85.7	93.5

A SUMMARY OF ALL DIGESTION COEFFICIENTS OBTAINED WITH SHEEP AT THE MAINE EXPERIMENT STATION.

	Number of animals.	Total dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%	%
Blue joint (cut late in July)	2	39.9	41.8	10.	56.5	36.5	43.2	37.0
Buttercup (in full bloom)	2	56.1	56.6	48.1	56.3	41.1	66.9	69.7
Barley hay	1	59.1	62.3	44.8	65.2	61.7	63.3	40.5
Clover hay (alsike mixed with a little timothy)	2	54.9	56.2	......	55.5	46.2	64.1	53.2
Clover, alsike	2	62.7	63.6	51.4	68.2	55.9	67.3	61.2
Clover, alsike in full bloom	2	61.9	62.7	53.0	64.0	51.0	74.1	35.1
Average 2 experiments, 4 animals ...	....	62.3	63.2	52.2	66.1	53.5	70.7	48.2
Clover, white in late bloom.	2	66.0	66.6	58.5	73.2	60.6	99.5	50.6
Corn fodder, southern (immature, no ears)	2	64.8	67.2	34.9	58.1	74.6	64.5	68.8
Corn fodder, southern (immature, no ears)	2	69.4	70.6	57.4	65.4	74.2	69.5	70.9
Corn fodder, southern (immature, no ears)	2	63.3	62.8	43.1	63.4	65.7	61.0	59.0
Average 3 experiments, 6 animals ...	....	65.8	66.9	45.1	62.3	71.5	65.0	66.2
Corn, sweet, partially matured, slightly frosted	2	60.9	63.1	23.4	59.0	70.2	59.4	67.5
Corn, sweet, whole plant mature. ...	2	69.7	73.5	39.4	61.8	76.7	72.1	76.9
Corn, sweet, whole plant, ears mature	2	70.9	72.7	44.0	71.5	74.6	73.1	77.
Average 3 experiments, 6 animals ...	....	67.2	69.8	35.6	64.1	73.8	68.2	73.8
Corn, flint, partially mature, slightly frosted	2	70.2	72.4	44.2	63.6	79.8	70.3	71.6
Corn, flint, whole plant, ears glazed,	2	70.6	72.4	52.9	61.8	75.6	72.6	70.2
Corn, flint, whole plant, ears glazed,	2	72.7	74.2	50.7	67.6	78.6	73.8	64.7
Corn, flint, whole plant, ears just forming	3	69.8	71.4	54.7	70.4	72.3	71.3	67.3
Corn, flint, whole plant, ears partially glazed	3	69.7	73.6	20.0	68.6	70.7	76.7	73.7
Average 5 experiments, 12 animals ..	....	70.6	72.8	44.5	66.4	75.4	72.9	69.5
Hungarian grass, green	2	63.4	65.6	35.5	62.4	67.8	65.8	52.3
Hungarian hay, (grass dried)	2	65.0	66.3	47.4	60.0	67.6	67.1	63.8
Hay (mixed, timothy mostly)	3	55.0	57.0	27.8	44.4	52.5	62.3	38.9
Orchard grass past bloom	2	54.4	55.8	35.0	58.5	57.5	54.4	57.2
Oat straw	2	50.3	52.0	......	......	57.6	53.2	38.3

A SUMMARY OF DIGESTION COEFFICIENTS—CONTINUED.

	Number of animals.	Total dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%	%
Red top, full bloom	2	57.6	59.3	24.3	60.4	61.2	59.1	44.2
Red top, full bloom	2	61.8	63.0	33.4	62.2	61.3	64.6	56.8
Average 2 experiments, 4 animals	....	59.7	61.2	28.9	61.3	61.3	61.9	50.5
Silage, southern corn, immature	2	63.2	66.3	14.9	46.6	73.9	65.6	65.3
Silage, southern corn, immature	1	64.4	65.8	48.2	64.8	66.7	65.4	67.8
Silage, southern corn, immature	3	63.6	64.8	49.6	59.9	67.5	64.1	67.9
Average 3 experiments, 6 animals	....	63.7	65.6	37.6	57.1	69.4	65.0	67.0
Silage, flint corn, partially mature	2	69.1	72.1	12.3	52.9	75.2	73.4	82.6
Silage, flint corn, whole plant, ears partially glazed	1	78.0	80.2	41.3	68.0	77.9	83.1	80.9
Silage, flint corn, whole plant, ears partially glazed	1	76.0	77.9	36.6	73.3	77.8	78.5	80.9
Silage, flint corn, whole plant, mature	3	75.7	77.9	39.8	67.4	78.5	78.9	87.1
Average 4 experiments, 7 animals	....	74.7	77.00	32.5	65.4	77.4	78.5	82.9
Silage (mature flint corn, sunflower heads, horse beans)	2	65.6	67.8	41.1	62.7	60.1	72.4	76.7
Silage (mature flint corn, sunflowers, whole plant, horse beans)	2	65.5	69.6	25.6	58.0	65.3	73.7	74.1
Silage (Sanford corn)	2	69.9	72.5	34.4	56.3	72.1	75.6	72.9
Timothy hay (fed with corn meal)	1	......	57.7	......	43.0	50.5	65.6	42.8
Timothy hay (fed with cottonseed meal)	1	......	61.2	.....	41.1	......	65.6	54.6
Timothy hay (fed with corn meal)	1	.....	59.1	......	42.1	53.6	66.1	45.5
Timothy, two weeks past bloom	2	51.6	52.4	......	45.2	42.8	58.9	55.0
Timothy, in full bloom	2	65.7	66.8	41.8	60.4	62.1	71.8	51.5
Timothy, past bloom	2	54.1	55.5	28.0	44.5	51.0	61.0	34.6
Timothy, early, cut July 9	2	60.4	61.1	48.2	58.9	58.7	63.7	56.9
Timothy, late, cut July 24	2	58.3	59.4	32.2	50.0	53.3	63.9	58.3
Timothy hay	2	58.5	60.1	29.6	44.1	56.4	63.6	74.3
Timothy hay	2	59.1	60.2	39.7	47.5	54.8	64.7	69.8
Timothy hay	3	53.7	55.0	29.4	45.2	48.7	60.7	50.6
Average 11 experiments, 20 animals	....	57.7	59.0	35.6	47.5	53.2	64.1	54.0
Wild oat grass in bloom	2	68.3	69.1	52.2	68.0	70.6	68.8	62.8
Wild oat grass in bloom	2	59.6	61.2	17.1	48.6	65.1	62.1	38.2
Average 2 experiments, 4 animals	....	64.0	65.2	34.7	58.3	67.9	65.5	50.5
Witch grass	2	59.9	61.0	40.3	64.2	67.6	62.1	60.0

A SUMMARY OF DIGESTION COEFFICIENTS—CONCLUDED.

	Number of animals.	Total dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%	%
Witch grass	2	62.4	63.6	41.5	52.9	57.9	69.0	54.5
Average 2 experiments, 4 animals	....	61.2	62.3	40.9	58.6	62.8	65.6	57.3
ROOTS.								
Beets, mangolds	2	78.5	84.8	16.4	74.7	42.3	91.3	
Beets, sugar	2	94.5	98.7	31.9	91.3	100.7	99.9	49.9
Potatoes	2	77.0	78.4	.....	44.2	......	90.9	13.0
Turnips, English flat	2	92.8	96.1	58.6	89.7	103.0	96.5	97.5
Turnips, rutabagas	2	87.2	91.1	31.2	80.3	74.2	94.7	84.2
MILL PRODUCTS.								
Corn meal (fed with hay)	3	93.3	93.6	61.9	78.7	.....	98.5	92.5
Corn meal (fed with hay and skimmed milk)	3	89.6	90.7	49.5	76.9	......	95.3	98.1
Average 2 experiments, 6 animals	....	91.5	92.2	55.7	77.8	......	96.9	95.3
Gluten meal	2	87.4	89.1	......	86.6	......	90.8	87.8
Pea meal	2	86.8	87.9	43.7	83.2	25.7	93.6	54.6
Wheat bran	2	58.8	62.8	......	73.7	......	67.5	82.6
Wheat bran	2	59.8	64.0	......	82.1	36.2	64.1	64.0
Average 2 experiments, 4 animals, wheat bran	...	59.3	63.4	......	77.9	36.2	65.8	73.3
Wheat middlings	2	74.9	77.2	......	78.9	......	82.6	85.1

EFFECTS OF TUBERCULIN ON TUBERCULOUS COWS.*

F. L. Russell.

A herd of ten cows and heifers that reacted to the tuberculin test during the fall of 1895 and the following winter were placed in quarantine in a stable built for them at considerable distance from other buildings. The stable was light and well ventilated and the cattle were well fed and cared for. In summer they had the run of a small pasture with dry feed in the barn when it was needed; in winter they were not confined in the barn, but were turned out in a sunny yard during the middle of the day when the weather was such that they could be comfortable out of doors. Without using any elaborate or extraordinary means, we endeavored to keep the animals under as healthful conditions as possible. When placed in quarantine none of the animals showed marked symptoms of being diseased, but on the contrary, were about as thrifty and vigorous looking animals as could be found anywhere. They were considered diseased simply because they reacted to the tuberculin test. A thorough physical examination failed to reveal any symptoms of disease aside from a slight cough in the case of two or three of them, and these did not cough any more than many other cows that were free from tuberculosis. In October, 1897, the last of these animals was killed and we now make our final report upon them, having made a partial report in the Annual Report of this Station for 1896. Besides the ten animals with which we started, we fed calves and pigs on the milk of these cows and some of these became diseased.

The table gives the result of all tests applied to the ten cows and heifers composing the quarantined herd.

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*See Annual Report of this Station, 1896, pp. 56–63.

TABLE GIVING THE RESULTS OF TESTS WITH TUBERCULIN MADE AT THE STATION DURING THE YEARS 1892 TO 1897 INCLUSIVE.

Date of Test.	Number of days since the last test was made.	Temperature at the time the tuberculin was injected—deg.	Maximum temperature on the day after the injection—deg.	Rise or decline (—) of temperature—degrees.	Remarks.
Topaz.					
February 14, 1896.....	First test.	102.1	**105.3**	**3.2**	**Reaction.**
March 8, 1896	23	101.8	102.2	.4	No reaction.
March 13, 1896	5	102.2	102.8	.6	No reaction.
March 21, 1896	8	102.3	101.8	—.5	No reaction.
May 1, 1896...........	41	102.	101.9	—.1	No reaction.
July 2, 1896............	62	102.6	101.9	—.7	No reaction.
August 18, 1896	47	102.4	102.	—.4	No reaction.
September 15, 1896 ..	28	102.2	Temperature not taken.		
November 3, 1896. ..	49	101.8	101.8	....	No reaction.
December 9, 1896.....	36	101.8	102.2	.4	No reaction.
January 13, 1897......	35	102.	**105.2**	**3.2**	**Reaction.**
January 27, 1897	14	101.6	102.9	1.3	No reaction.
February 17, 1897.....	21	100.9	101.6	.7	No reaction.
April 29, 1897	71	102.9	103.8	1.1	No reaction.
May 20, 1897...........	21	102.3	102.6	.3	No reaction.
June 2, 1897...........	13	101.6	102.	.4	No reaction.
June 15, 1897.........	13	102.2	102.	—2	No reaction.
June 25, 1897..........	10	102.5	103.	.5	No reaction.
July 7, 1897............	12	103.2	102.4	—.6	No reaction.
July 10, 1897	3	103.	101.	—.2	No reaction.
August 19, 1897	40	102.1	102.2	.1	No reaction.
September 28, 1897...	40	101.8	102.4	.6	No reaction.
October 11, 1897.......	13	101.2	102.	.8	No reaction.
Dunkard Girl.					
August 13, 1895........	116	101.	**107.4**	**6.4**	**Reaction.**
August 29, 1895........	16	101.6	**107.4**	**5.8**	**Reaction.**
September 4, 1895....	6	101.4	102.5	1.1	No reaction.
September 14, 1895 ...	10	102.6	101.4	—1.2	No reaction.
October 8, 1895........	424	102.7	**105.**	**2.3**	**Reaction.**
October 19, 1895........	10	101.6	Temperature not taken.		
October 31, 1895.......	12	101.7	102.4	.7	No reaction.
November 20, 1895....	20	101.8	**104.8**	**3.**	**Reaction.**
December 7, 1895.....	17	101.	101.9	.9	No reaction.
January 3, 1896	27	102.	**106.2**	**4.2**	**Reaction.**
January 10, 1896.......	7	101.6	101.2	—.4	No reaction.
February 24, 1896....	14	101.3	101.2	—.1	No reaction.
February 19, 1896.....	26	101.5	100.9	—.6	No reaction.
July 2, 1896............	134	102.	103.	1.	No reaction.
August 18, 1896	47	101.7	101.6	—.1	No reaction.
September 16, 1896 ...	29	101.7	Temperature not taken.		
November 3, 1896.....	49	103.	101.4	—1.6	No reaction.
January 13, 1897......	72	101.5	102.4	.9	No reaction.
Kate.					
February 14, 1896.....	185	100.3	**105.3**	**5.**	**Reaction.**
March 8, 1896.........	23	101.4	102.8	1.4	No reaction.
March 13, 1896	5	100.4	102.6	2.2	No reaction.
March 21, 1896	8	101.6	102.	.4	No reaction.
May 1, 1896............	41	101.1	101.8	.7	No reaction.
July 2, 1896	62	102.8	102.5	—.3	No reaction.
August 18, 1896........	47	101.7	102.3	.6	No reaction.
September 15, 1896 ...	28	101.3	Temperature not taken.		
November 3, 1896.....	49	103.	103.	....	No reaction.
September 28, 1897 ...	329	100.8	102.3	1.5	No reaction.
October 11, 1897.......	13	101.7	102.3	.6	No reaction.

RESULTS OF TESTS WITH TUBERCULIN—CONTINUED.

Date of Test.	Number of days since the last test was made.	Temperature at the time the tuberculin was injected—deg.	Maximum temperature on the day after the injection—deg.	Rise or decline (—) of temperature—degrees.	Remarks.
Mina D.					
April 30, 1896	72	101.2	**105.9**	**4.7**	**Reaction.**
July 2, 1896	63	101.7	**105.8**	**4.1**	**Reaction.**
July 7, 1896	5	101.3	102.7	1.4	No reaction.
August 18, 1896	42	101.8	**104.8**	**3.**	**Reaction.**
August 20, 1896	2	102.7	102.7	....	No reaction.
August 29, 1896	9	102.3	102.7	.4	No reaction.
September 15, 1896	17	101.8	Temperature not taken.		
November 3, 1896	49	101.1	102.3	1.2	No reaction.
September 28, 1897	329	101.2	105.8	4.6	**Reaction.**
October 11, 1897	13	100.4	102.	1.6	No reaction.
Ruth C.					
February 14, 1896	100	101.2	**106.**	**4.8**	**Reaction.**
March 8, 1896	23	100.8	**103.6**	**2.8**	**Reaction.**
March 13, 1896	5	101.7	100.8	—.9	No reaction.
March 21, 1896	8	101.6	101.7	.1	No reaction.
April 30, 1896	40	103.	101.6	—1.4	No reaction.
July 2, 1896	63	102.2	**105.2**	**2.9**	**Reaction.**
July 7, 1896	5	101.5	101.3	—.2	No reaction.
August 18, 1896	42	102.7	**104.3**	**1.6**	**Reaction.**
August 20, 1896	2	103.4	101.8	—1.6	No reaction.
August 29, 1896	9	103.	102.2	—.8	No reaction.
September 15, 1896	17	102.	Temperature not taken.		
November 3, 1896	49	102.1	102.5	.4	No reaction.
December 9, 1896	36	101.3	101.2	—.1	No reaction.
January 13, 1897	35	101.6	102.	.4	No reaction.
January 27, 1897	14	100.6	103.	2.4	No reaction.
February 17, 1897	21	100.8	101.3	.5	No reaction.
Agnes 2.					
February 14, 1896	100	101.8	**106.**	**4.2**	**Reaction.**
March 8, 1896	23	102.6	**104.**	**1.4**	**Reaction.**
March 13, 1896	5	101.	**103.2**	**2.2**	**Doubtful.**
March 21, 1896	8	101.4	Temperature not taken.		
April 30, 1896	40	101.2	100.	—1.2	No reaction.
July 2, 1896	63	102.7	**103.7**	**1**	**Doubtful.**
August 18, 1896	46	102.1	102.3	.2	No reaction.
September 15, 1896	28	101.8	Temperature not taken.		
November 3, 1896	49	102.2	102.2	....	No reaction.
Hallie.					
February 14, 1896	100	101.7	**106.6**	**4.9**	**Reaction.**
March 8, 1896	13	102.	**105.6**	**3.6**	**Reaction.**
March 13, 1896	5	102.2	**103.5**	**1.3**	**Doubtful.**
March 21, 1896	8	100.2	102.2	2.	No reaction.
April 30, 1896	40	103.1	**104.3**	**1.2**	**Doubtful.**
July 2, 1896	63	101.8	**103.4**	**1.6**	**Doubtful.**
July 7, 1896	5	101.3	101.7	4	No reaction.
August 18, 1896	42	102.	**105.2**	**3.2**	**Reaction.**
August 20, 1896	2	101.8	**105.1**	**3.3**	**Reaction.**
August 29, 1896	9	101.2	102.	.8	No reaction.
September 15, 1896	17	101.7	Temperature not taken.		
November 2, 1896	48	101.7	101.6	.1	No reaction.
February 17, 1897	97	101.6	**105.3**	**3.7**	**Reaction.**
September 28, 1897	223	100.8	101.7	.9	No reaction.
October 11, 1897	13	100.8	101.8	1.0	No reaction.

RESULTS OF TESTS WITH TUBERCULIN—CONTINUED.

Date of Test.	Number of days since the last test was made.	Temperature at the time the tuberculin was injected—deg.	Maximum temperature on the day after the injection—deg.	Rise or decline (—) of temperature.—degrees.	Remarks.
Grace 2.					
February 14, 1896	100	99.6	**106.5**	**6.9**	**Reaction.**
March 8, 1896	23	102.	**105.5**	**3.5**	**Reaction.**
March 13, 1896	5	102.	102.8	.8	No reaction.
April 30, 1896	48	100.	100.2	.2	No reaction.
July 2, 1896	63	102.3	**104.7**	**2.4**	**Reaction.**
July 7, 1896	5	101.7	101.8	.1	No reaction.
August 18, 1896	42	102.	102.	....	No reaction.
September 15, 1896	28	101.4	Temperature not taken.		
November 3, 1896	49	101.5	102.2	.7	No reaction.
December 9, 1896	37	101.4	102.5	1.1	No reaction.
January 13, 1897	35	102.1	102.	.1	No reaction.
January 27, 1897	14	100.8	102.4	1.6	No reaction.
February 17, 1897	21	101.5	**104.1**	**2 1**	**Reaction.**
Melinda 2.					
February 14, 1896	100	101.5	**106.**	**4.5**	**Reaction.**
March 8, 1896	23	101.2	**104.**	**2.8**	**Reaction.**
March 13, 1896	5	99.8	100.9	1.1	No reaction.
March 21, 1896	8	101.7	101.4	—.3	No reaction.
May 1, 1896	41	100.3	101.4	1.4	No reaction.
July 2, 1896	62	102.	102.7	.7	No reaction.
August 18, 1896	47	101.9	102.	.1	No reaction.
September 15, 1896	28	101.3	Temperature not taken.		
November 3, 1896	49	102.	102.1	.1	No reaction.
December 9, 1896	36	99.	101.4	2.4	No reaction.
January 13, 1897	35	102.	102.8	.8	No reaction.
January 27, 1897	14	100.5	102.5	2.	No reaction.
February 17, 1897	21	102.4	102.2	.2	No reaction.
April 29, 1897	71	101.4	102.8	1.4	No reaction.
May 14, 1897	15	103.4	103.	—.4	No reaction.
May 20, 1897	6	103.2	103.6	.4	No reaction.
June 15, 1897	26	104.4	**105.2**	**.8**	**Reaction**
June 25, 1897	10	104.0	104.	.0	No reaction.
Trilby.					
February 14, 1896	First test.	102.	**106.3**	**4.3**	**Reaction.**
March 8, 1896	23	101.	**105.3**	**4.3**	**Reaction.**
March 13, 1896	5	101.7	103.2	1.5	No reaction.
March 21, 1896	8	101.8	102.1	.3	No reaction.
May 1, 1896	41	102.1	101.6	—.5	No reaction.
July 2, 1896	62	102.7	**105.5**	**2.8**	**Reaction.**
July 7, 1896	5	102.	101.7	—.3	No reaction.
August 18, 1896	42	102.5	103.2	.7	No reaction.
September 15, 1896	28	101.9	Temperature not taken.		
November 3, 1896	49	102.	102.	....	No reaction.
December 9, 1896	36	102.	102.2	.2	No reaction.
January 13, 1897	35	101.8	102.	.2	No reaction.
January 27, 1897	14	100.8	102.7	1.9	No reaction.
February 17, 1897	21	100.4	102.	1.6	No reaction.
April 29, 1897	71	102.	103.	.1	No reaction.
May 20, 1897	21	100.1	101.	—.1	No reaction.
June 2, 1897	13	100.8	101.	.2	No reaction.
June 15, 1897	13	101.7	101.6	—.1	No reaction.
June 25, 1897	10	103.	102.2	—.8	No reaction.
July 7, 1897	12	102.6	101.8	—.8	No reaction.
July 10, 1897	3	101.8	101.1	—.7	No reaction.
August 19, 1897	40	102.	102.	.0	No reaction.
September 28, 1897	40	101.1	102.	.9	No reaction.
October 11, 1897	13	101.	101.4	.4	No reaction.

POULTRY HOUSES.

As noticed in the report for 1896, we see that the animals slightly affected with tuberculosis when tested with tuberculin failed to react oftener than they reacted, and the reactions seem to bear no relation to the length of time intervening between tests. The first of the animals killed was Dunkard Girl. When she was killed January 15, 1897, she had been diseased nearly a year and a half, yet the disease had made little advance. She had never exhibited any physical signs of disease. At the time she was killed she was decidedly fat. Two guinea pigs inoculated from her died with tuberculosis.

February 27, 1897, Ruth C. was killed. It had been over six months since she had reacted. But she had been coughing to a noticeable degree for more than a year, and had not been as thrifty as the rest of the herd. How much of this lack of thrift was due to her diseased condition is uncertain as she apparently belonged to rather a frail type before she gave evidence of disease. The autopsy revealed only a small area of diseased lung and two enlarged lymphatic glands.

June 17, 1897, Grace was killed in an advanced stage of tuberculosis. When she calved April 24, 1897, she was in good flesh and apparently perfectly well, and she did well at the time of calving, but very soon afterwards it was noticed that she was rapidly losing flesh and she manifested other marked symptoms of tuberculosis, including a severe cough, rough coat, irregular appetite, and considerable fever. Her temperature was taken frequently and was rarely found below 104° and was often above 105°. An examination of the lungs ten days before she was killed revealed the fact that they were considerably diseased. She had some appetite and considerable strength at the time she was killed. At the autopsy a very large number of tubercles, varying in size from a pin head to three inches in diameter, were found scattered through both lungs, and attached to both the parietal and visceral pleura. The bronchi contained much frothy mucus. The mediastinal lymphatic glands were enlarged and much congested. The tubercles presented no evidence of degenerative changes. She had not been tested since she calved. Her temperature had been constantly high.

July 1, 1897, Melinda was killed. She was very much reduced in flesh and weak. Had eaten but little for ten days previously. Melinda calved May 11, 1897, and was at that time in good flesh and apparently perfectly well. Soon after calving she commenced to fail. Developed a severe cough, had a rough dull coat, her appetite was irregular and she began to fail in her milk. About the 20th of May she went out to pasture in good feed. Was put into the barn at night and fed grain. Three weeks before she was killed we were able to discover lung lesions by a physical examination. At the autopsy we found in the abdominal cavity innumerable small tubercles over the surface of the mesentary and diaphragm. In the walls of the uterus were a considerable number of small abcesses one-half inch in diameter. Scattered quite evenly through both lungs were tubercles from the size of a pin head to one-half inch in diameter and so thick that they seemed to fill nearly the entire volume of the lungs. The parietal and visceral pleura in the inferior anterior region, and on the right side the parietal pleura were nearly covered with small tubercles. The mediastinal glands were tuberculous and much enlarged. One of them was ten inches long and five inches in diameter. Except in the walls of the uterus, there was no breaking down of the tuberculous tissue but it was all apparently of recent growth.

The other six animals of this herd were killed October 12 and 14, 1897, and the following conditions noticed:

Agnes, 2d, had apparently always been well except that she reacted to the tuberculin test. The only lesions found were in two lymphatic glands and they showed very slight evidence of disease. A guinea pig inoculated from one of these glands killed after nine weeks showed no evidence of disease, so that what evidence we have goes to show that this cow had recovered from tuberculosis.

Hallie. This cow had always seemed well except for an increasing difficulty in breathing which had been noticeable for six months before she was killed, and a cough which had been troubling her for three months and constantly growing worse. We found tuberculous lesion in the inguinal, mediastinal and post pharyngeal lymphatics, and a few small tubercles scattered through both lungs. One of the mediastinal glands measured

12x3x2 inches. One of the pharyngeal glands was fully seven inches in diameter and consisted of a very thin walled abcess filled with thin, watery pus. This would account for the difficult breathing. The lung tubercles had cheesy centers.

Mina D. She had never shown symptoms of disease except slight unthriftiness. Tubercular lesions were found in one inguinal and in many of the mesenteric and mediastinal lymphatic glands and both lungs. Tubercles in lungs were scattered and not large, except one which measured 5x4x4 inches. All the diseased tissue was somewhat cheesy.

Kate. Had always been well. The only lesion found was one cheesy, mediastinal gland, one inch in diameter.

Trilby. Has show no symptoms of disease. The only lesion found was one mediastinal gland with cheesy center.

Topaz. Had always appeared to be well. Two mediastinal glands were enlarged and cheesy. One measured 4x3x2 inches and the other 2x1x1 inches.

A study of these cases shows us, that, kept under exceptionally good conditions as these cattle were, five of them kept the disease in check, so that it made practically no advancement. In the case of three others, but little advance was made, while in two cases the disease had nearly reached a fatal termination when the animals were killed. On the whole, we cannot see that the exceptionally good care that these animals received had any effect on the progress of the disease. It may have retarded the progress of the disease, but if so the fact is not sufficiently clear to lend much weight to the argument that tuberculosis can be successfully controlled by simply maintaining animals under good hygienic conditions. Twenty per cent of deaths is probably as high a percentage as one could reasonably expect among ordinary tuberculous herds kept under poor or only fair hygienic conditions, if to begin with all cases that presented any physical symptoms of disease were removed.

The most of these animals were giving milk during quite a part of the time, and their milk was fed to calves and pigs. The pigs were fed some meal, and the calves had a little hay, but their principal food was milk from the cows. Four pigs and fifteen calves in all were fed with milk from these animals. The pigs were killed when they weighed about 175 pounds and the

calves at from six to eight weeks old, and when killed were carefully examined. One of the pigs and two of the calves were found to be tuberculous.

The first of the calves to be found diseased was a black calf purchased when it was three days old, out of an apparently healthy cow. It was killed June 3, 1897, when three months old. It was kept to this age because of difficulty in getting a calf to take its place to use the milk. It grew rapidly and was very large and fat when killed. Had never shown symptoms of disease. Had been tested with tuberculin three times, the last time May 6, 1897, but did not react. The autopsy revealed many small tubercles in the liver, one tubercle one-half inch in diameter in the lungs, and three lymphatic glands slightly diseased. A guinea pig was inoculated from a piece of the lung tubercle and died July 17, 1897, from general tuberculosis.

The second calf that was found tubercular was dropped by Kate, April 21, 1897, and was never outside of the barn where it was dropped. It will be noticed from the autopsy of Kate that she was found very slightly diseased. May 14 this calf was tested with tuberculin and reacted with a maximum temperature of $105.^{\circ}4$. May 19 it was tested again and reacted with a temperature of $104^{\circ}.2$. June 25 it was tested again and failed to react. June 29, 1897, this calf was killed. It had always seemed well and was very fat when killed. The autopsy revealed four mediastinal lymphatic glands which contained a large number of small yellow foci each about the size of a pin head and calcareous. The glands were perceptibly enlarged. A guinea pig inoculated with a piece of one of these glands died September 1, and was found to have general tuberculosis.

The hog that developed tuberculosis while being fed on milk from the tuberculous cows was one of two that were kept for nearly a year in the basement of the stable where the cows were. They had access to the manure from the cows. When killed December 3, 1897, this hog was about fifteen months old. Had always appeared well. The autopsy revealed tuberculous lesions in the liver and lymphatic glands. No tuberculin test had been applied.

A COMPARISON OF THE TEMPERATURES OF HEALTHY AND TUBERCULOUS COWS.

F. L. Russell.

Beginning the second of March, 1897, the temperature of six of our tuberculous cows and of six other cows that were considered sound were taken three times a day for about forty days. The temperatures were taken at 9 A. M., 12.30 and 4.30 P. M.

We must regard the results as negative, as far as showing any difference in temperature between well animals and those slightly tuberculous, is concerned. In the following table the summary of the observations is given. The succeeding tables contain the record of the observations as made.

THE AVERAGE HIGHEST AND LOWEST TEMPERATURE, THE GREATEST VARIATION AND THE GREATEST DAILY VARIATION IN TEMPERATURE OBSERVED IN SIX WELL AND SIX SLIGHTLY TUBERCULOUS COWS DURING SIX WEEKS' TIME.

Cow Numbers.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Average of.
Average Temperature.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Well cows	100.9	101.4	101.4	100.9	101.1	101.8	101.3
Tuberculous cows	100.8	101.2	101.5	100.9	101.4	101.4	101.2
							Extreme of.
Highest Temperature.							
Well cows	101.8	101.4	102	102	102.1	103	103.0
Tuberculous cows	102	103	103	102.4	104.4	103	104.4
Lowest Temperature.							
Well cows	98.6	100	100.4	99.7	98.9	100.1	98.6
Tuberculous cows	99.2	99	99	99	99.8	99.8	99.6
Greatest Variation.							
Well cows	3.2	2.4	1.6	2.3	3.2	2.9	4.4
Tuberculous cows	1.8	4	4	2.4	3.8	3.2	4.0
Greatest Daily Variation.							
Well cows	2.9	2.0	1.3	2	2.6	2	2.9
Tuberculous cows	1.8	2.3	3.4	2.1	3.2	2.2	3.2

THE TEMPERATURES OF SIX WELL COWS TAKEN AT 9 A. M., 12.30, AND 4.30 P. M., FOR SIX WEEKS.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
	101	100.7	100.9	100.1	100.9	100.9
March 2	100.9	100.7	100.8	100	100.8	100.1
	100.7	101	100.6	100.6	101	101.9
	100.9	102	101.9	102	102	102.1
March 3	101	101.7	101.8	100.7	100.8	101.7
	100.9	102.1	101.7	100.9	101.8	102.3
	101	101.8	102	100.7	101.6	101.9
March 4	100.5	101.8	100.8	101.1	101.6	102.3
	101.7	101.8	102	101.7	101.6	101.7
	100.8	102.2	101.8	101.6	101.9	101.4
March 5	101.3	101.5	101.4	101.4	100.8	101.9
	101.2	101.6	101.4	101.1	101.2	101.9
	101.4	102	101.9	101.5	102.1	101.9
March 6	100.9	101.4	100.6	101.3	101.3	102.2
	101.4	102.1	101.8	101.8	102.1	102.8
	101.3	101.6	101.8	101.8	101.7	101.9
March 7	101.8	100.7	101.3	100.1	101	102.4
	101.4	101.8	101.4	101.1	102	102.4
	100.4	101.6	100.1	100.2	101.4	101.2
March 8	100.7	101.6	100.9	101	100.6	102.1
	101.4	102.4	101.8	101.2	101.4	102.8
	101	101.7	101.4	101	101.7	101.9
March 9	99.7	99.5	100.9	100	100	102
	101.4	101.5	101.6	101.5	101.6	102.8
	101.5	101.2	101.5	100.4	101.6	101.6
March 10	101	101.1	101.4	101.4	101.3	102
	101.3	101.7	101.4	100.9	101.8	101.8
	100.9	101.6	101.4	100.6	101.6	101.9
March 11	100.7	101.1	101.1	100.1	101	102
	100.9	101.9	101.6	101.1	101 2	102
	100	101.9	102	101	101.4	101.8
March 12	100.2	100.9	101.1	100.8	100.8	102
	101.2	101	101.8	100.6	101.6	102.6
	101.3	101.2	101.8	100.7	100.9	101.4
March 13	101.1	101.4	101.4	100.4	100.3	103
	101.4	101.7	101.4	100.8	101.2	102.8
	100.5	102	101.7	99.7	101.9	102.1
March 14	100.6	100.9	101.6	100.6	102	102.3
	100.9	102.1	101.7	101.4	102.1	103
	99.2	101.2	100.4	100.8	101.2	102.1
March 15	98.6	100.4	101.3	100	98.9	102.4
	101.5	101.6	101.6	100.2	101.5	102.7
	101	101.7	101.7	100.6	101.2	102.2
March 16	101.2	101.4	101	100.6	100.4	102
	101.4	101.6	101.2	100.9	101.4	102.7
	99.8	101	101.5	101.1	101	102
March 17	101.1	101.6	101.1	100.7	101.1	102.3
	101.6	101.4	101.2	101	101.9	102.6
	101.2	101	101	100.6	101.2	102.5

TEMPERATURES OF SIX WELL COWS—CONTINUED.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
March 18	101.8	100.7	100.7	100.8	101	102.3
	100.4	101.4	101	101	102	102.3
	101.7	101.6	101.8	100.8	101.2	102
March 19	100.6	101	101	100.8	100	102.2
	101.4	101.6	101	100.5	101.3	102.3
	101.4	101.7	101.7	100.5	101.9	101.4
March 20	101.4	101.7	101.5	101.3	101.4	101.6
	101	101.8	101.4	101.6	101.6	101.9
	100.8	101.9	101.6	100.2	101.6	101.9
March 21	101	101.8	101.4	100.6	101.4	
	101.7	102	101.9	101.3	101.3	102.6
	101	102.2	101.6	100.2	100.5	102
March 22	....	....	....	....	....	....
	....	....	....	....	....	....
	....	....	....	....	....	....
March 23	....	....	....	....	....	....
	....	....	....	....	....	....
	100.8	101.2	101.4	101.4	101.6	101.4
March 24	100.4	100.5	101.2	101.2	101.4	101.5
	100.9	102	101.9	101.3	101.8	101.4
	100.9	101.3	101.7	100.4	102	101.5
March 25	100.6	101	100.9	100.8	101.2	101.6
	101	101.4	101.2	101.2	102	102
	101.5	101.4	101.8	100.6	101	101.5
March 26	101.6	101	100.8	101.4	101	101.4
	101.4	101.7	101.1	101	101.2	101.7
	101.2	101.4	101.4	100.4	100.6	101.3
March 27	100.4	100.6	101.2	100.1	100.6	101.4
	101.6	102.1	101.6	101.6	101.4	101.6
	100.8	101	101.4	100.9	101.6	101.6
March 28	101.4	101.6	101.5	101	101.5	101.7
	101.7	101.8	101.7	101.1	101.4	101.9
	100.8	101.7	101.4	100.7	101.1	101.2
March 29	101 2	101.4	101.1	100.8	101.3	101
	101	100.6	101.2	101	101.6	101.6
	100.6	101	101.2	100.6	101.9	101.6
March 30	100	100.8	101.2	101.1	100	101.2
	101	101.8	101.3	100	101.4	101.8
	101	101.3	101.3	100.6	101.4	102.1
March 31	100.7	100.8	101.2	101.1	100.4	101.8
	100.7	101.7	101	100.9	101.4	101.9
	101	101.7	102	101.2	101.9	101.9
April 1	100.8	101.2	100.6	101	101.6	100.8
	101	102	101.6	101.3	101 6	101.6
	100.4	101.9	101.9	100.8	101.6	101.9
April 2	100.6	101	101.4	101.1	100.8	101.3
	101.4	101.4	101.2	101	101.5	101.5
	100	101.3	101.9	100.9	101.2	101.5
April 3	100.9	101.4	100.8	100.2	101	100.6
	101.6	101.7	101.3	101.1	101.5	101.5
	100.8	101.4	101.3	101.5	102	102

TEMPERATURES OF SIX WELL COWS—CONCLUDED.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
April 4	101 101.2 100.6	101.2 101.9 101.1	101.5 101.8 100.8	101.3 101 100.5	101.9 102 101.8	101.8 101.6 101.5
April 5	100.8 101 100.6	101.1 101.5 101.2	101.1 100.9 101 2	100.8 100.8 100.6	101.3 101.1 101.5	101.2 100.9 101.8
April 6	101.2 101.4 100	101.3 101.6 101.9	101 101.5 102	100.8 101.1 101.9	101.1 101.7 101.9	101.5 102.1 101.4
April 7	101.1 101 99.7	101.1 102 101.9	100.7 101.6 101.9	101.4 101.4 101.4	100.9 101.8 102	101.1 101.8 101.8
April 8	100.8 101 100	101 101.8 102	101.2 101.9 102	100.3 100.7 100.7	101.6 101.9 100.7	101.2 101.9 100.5
April 9	100.6 99.3	101.5 100	101.6 101.4	100.8 100.9	101 101.6	100.9 101.6

THE TEMPERATURES OF SIX SLIGHTLY TUBERCULOUS COWS TAKEN AT 9 A. M., 12.30 AND 4.30 P. M. FOR SIX WEEKS.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
March 2	99.4	100.3	101.6	100.4	101.3	100.4
March 3	100.8 100.5 101	101 100.9 101.2	101.8 101.2 101.4	100.9 100.4 101.6	101.2 101 102.4	101.4 100.4 102
March 4	100.8 100.7 99.2	100.4 101.8 100.4	101.2 100.8 101.7	101 101.3 100.1	101 100.2 102	100.6 100.2 100.5
March 5	100.1 100 99.4	101.1 101 100	101 101.6 101.2	100 100 99	101.7 100.5 101	100.2 99.8 100.2
March 6	100 101 101	100.4 102 101.4	101.3 100.6 102.6	100.1 102.1 101.4	101.3 100.9 101	100.8 104.1 103
March 7	100.6 101.3	101 101.2	101.7 102	101.9 100	101.2 102	101.4 100.6
March 8	100 100.8 101	99 101 101.2	100.6 100.2 101.8	100.2 100.1 101.2	99.8 100 102.6	101.4 102.1 101

TEMPERATURES OF SIX SLIGHTLY TUBERCULOUS COWS—CONTINUED.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
March 9	101 100.4 100	100.6 100.1 99.8	100.8 100.2 100	100.6 99 100.1	100.2 100.8 101	101.2 102 102.2
March 10	100.6 101.1 101	101 99.8 100.8	101.2 100.2 102	101 101.8 101.4	101 100.2 102.2	100.8 .... 101.6
March 11	99.6 101 101	100.4 100 102	101.6 99.4 102.8	100.6 100.8 101.4	101.8 102 103.2	101.4 100.8 101.4
March 12	101 100.8 101	101.2 102 101.4	101.6 99.9 100.8	100.8 100.2 99.8	101.4 102 102.6	102 102 100.8
March 13	101.2 100.8 100.4	101 100.4 102	101.6 101.9 101.3	101 100.1 101	101.2 102 102.8	100.8 100 102
March 14	100.4 101	100 102.4	101 101.2	100.3 101.4	101.2 101.2	100.4 101.4
March 15	100 101.2 100.3	100.4 99.5 101.8	101.6 102 101.2	100.2 100.3 101	100.8 100.1 102	100.6 100.6 100.8
March 16	100 101 100.8	101.2 101.3 101.1	101.6 100.4 101.4	101 101 102.2	100.2 101.1 103.4	101.6 101.5 101.4
March 17	100.6 100.5 100.4	102 102 102.4	101.6 102.1 102	100 100.8 100.1	101 101.4 101	101.1 101.3 101.4
March 18	100.8 101 101.5	101.4 100.5 101.8	101 101 102	100 101.3 101.4	100.4 100.9 104.4	101 101.2 101
March 19	100.4 100.2 101	100.6 101 101.6	101.8 101.6 102	100.8 100.9 100.8	101.2 101.4 102	101 101.1 100.7
March 20	101 101.4 101	101 100.8 102	101.6 99 100	100.6 100 99.6	100 100.8 101.4	100.8 101.2 101.3
March 21	100.4 101	100.6 .... 101.5	101.8 102	100.8 .... 101.3	101.2 .... 102.2	101 .... 101.6
March 22	101 101.4 100.3	101.6 100.6 101.8	101.4 101.2 102	100.8 100.1 100.2	101 101 100.1	101.4 101.3 100.8
March 23	100 101	100.4 101.4	101.8 103	100.6 101	101 103.4	101.4 103
March 24	101 101.3 101	100.2 101.5 101.2	102 101.9 101.7	101.3 101.7 101	101.8 101 100.8	101.4 102 101.6
March 25	100 99.8 101.8	101.4 101.9 103	101.6 101.2 101.4	100.4 100.4 101	101.4 101 103.6	100 100.2 101.2

TEMPERATURES OF SIX SLIGHTLY TUBERCULOUS COWS—CONCLUDED.

Date.	Number of Cows.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	°F.	°F.	°F.	°F.	°F.	°F.
March 26	101.6 100.2 102	102 100.1 102.6	102 101 101.8	101 100.8 101.6	101.4 101.3 102.5	101.2 101.1 102
March 27	100.4 101.9	100.8 102	101.2 101.6	101 100.9	101.1 101.3	101 101.4
March 28	100.8 101 101.2	100.6 100.4 101	101.2 101.2 101.4	101 101.3 101.6	Calved	100.8 101.1 102
March 29	101.2 101.1 102	101.1 100.9 101.9	101 101.2 103	101.4 101.6 101	....	101.3 101.4 101.4
March 30	101 100.9 100	101.1 101.6 101	101 101.3 101.1	100.6 101 100.6	....	101.4 101.5 101.4
March 31	99.6 101.2 99.8	101 101 100.8	101.6 101.1 101	100.8 100 100.6	....	101.8 101.6 101.7
April 1	101.2 101.2	100.6 101.4	101.4 101.6	101 102.4	100 101.2	101.3 101.8
April 2	99.8 100 101.2	101 100.9 101.8	102.2 102 102.4	101.2 101.6 101	102 101.3 102	102 101 102.2
April 3	100.2 101 102	100.8 100.4 102.2	102 101.4 103	101.4 101.5 101.4	102 101.8 102.8	101 100.9 101.6
April 4	100 101.2 101.8	101 6 101 102	102.8 102 102.8	101 102.1 101	101.4 101.8 102	101.8 101.4 102.4
April 5	99 101.6	102.6 102.4	102 102.6	101.4 101.6	101.8 102.5	102 102.2
April 6	101.4 102 101	101.2 101.8 101.6	102 101.4 102.8	101.4 101 101	101.6 101.4 102.4	102.6 102 102.6
April 7	100.6 101 101.8	101.2 100.8 102	102.6 102 102.8	100.8 101.2 101	100 100 102	102 101.4 102.2
April 8	101 101.3 101.6	100.8 100 101.2	103 102 102.1	101 101.6 101	100.6 101 102	101.8 101.7 102.4
April 9	100 101.4	101 103	102 102.6	101.4 100.6	101.6 103	102 102

NOTES ON INSECTS OF THE YEAR.

F. L. Harvey.

Stone Flies or the nymphs of these interesting insects are often received for determination. The nymphs are found in streams under stones, and the flies in damp or shaded places. Some of the smaller species known as Snow Flies come out early in the spring and are found on the surface of the snow and often fly into buildings. They may be known by the square thorax and broad, plaited hind wings, which lie flat on the abdomen when folded. The antennae are long and the veins of the wings prominent. They are not injurious. The nymphs are the favorite food of brook trout. See figs. 1 and 2.

The Cocks-comb Gall of the elm was received this season and may be added to the pests attacking that favorite shade tree in Maine. These galls are the work of a species of plant louse.

The Zebra Caterpillar (*Mamestra picta*) is a common insect in Maine, doing considerable damage to various crops. They are particularly bad in gardens. They were reported the past season as damaging the silks to sweet corn and feeding on turnips. They were quite bad on peas in gardens. These are handsome caterpillars of a pale yellow color, with three broad black stripes running length wise of the body, crossed by numerous narrow, pure white lines. They curl up like cut-worms when disturbed. The moths have dark chestnut fore wings and pale yellow hind wings and expand one and three-fourths inches. See fig. 3.

The Potato-Stalk Borer (*Gortyna nitela*) was reported as doing considerable damage to potatoes in Western Maine the past season. This insect is on the increase in Maine. The larva bores into the pith of potato stalks, causing them to wilt. The wilting plants should be pulled and burned so as to kill the worms within them.

The Apple-tree Tent-Caterpillar and the Forest Tent-Caterpillar were very abundant the past season in the west-

ern and southwestern parts of the State. As it was an off bearing year the orchards of Maine were shamefully neglected. Tent-caterpillars were allowed their own way, and it was common to see nice orchards badly eaten, and from one to several tents in a tree.

The abundant crop two years ago, and consequent low prices, the small crop of last season, with small returns, combined to discourage fruit growers and cause the neglect of orchards. We believe in periods of ten years, that the orchard is the best paying part of the farm. To turn the orchard over to the ravages of insects and fungi in off bearing years is a short sighted policy.

In a shy bearing year, trees have the opportunity to regain vigor from overbearing and lay up material for full bloom the following year. Nourishment is elaborated by the leaves and therefore foliage-eating insects sap the vitality of trees. The best time to strike insects that attack the fruit a hard blow, is in shy bearing years, when the food supply is limited.

By the neglect of orchards last year, tent and forest-caterpillars will be abundant this season.

We are glad to know that orchardists are becoming impressed by the fact that the best way to cope with tent-caterpillars, especially in young orchards, is to gather the egg clusters during the winter, or when the leaves are off.

The indiscriminate destruction of all kinds of eggs found attached to the limbs of apple trees would be bad policy, as beneficial and injurious insects would suffer alike. It would be but little trouble to send specimens of egg clusters found to the Station and learn which kinds should be protected. Several parties have availed themselves of this privilege the past season, and in all cases among the lots of eggs sent were several cocoons of beneficial Ichneumons.

Beech-bud Insect. We received from Mrs. Florence W. Jaques, Farmington, Maine, a lot of beech buds that were killed by an insect. They were the terminal buds, and had turned brown. An examination showed that the young leaves had been eaten and that the insect had made his exit by boring a small round hole through the scales near the base of the bud. This insect must do its work early in the spring, as the speci-

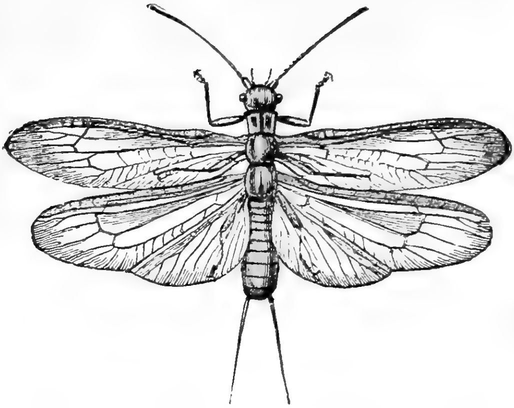

FIG. 1.

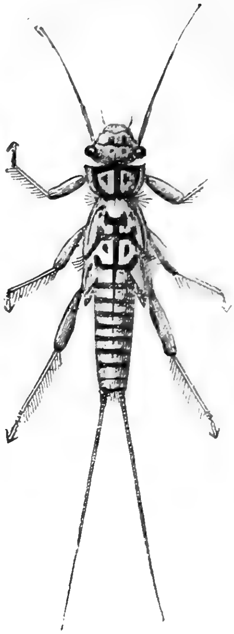

FIG. 2.

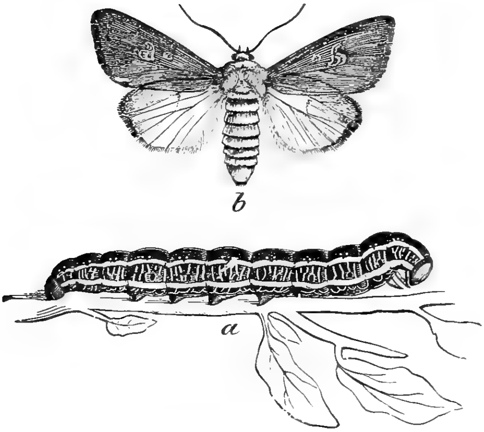

FIG. 3.

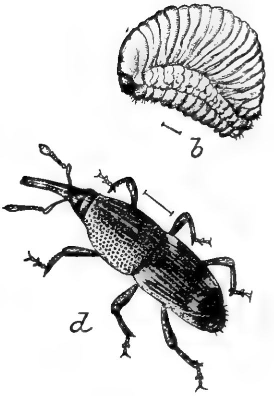

FIG. 4.

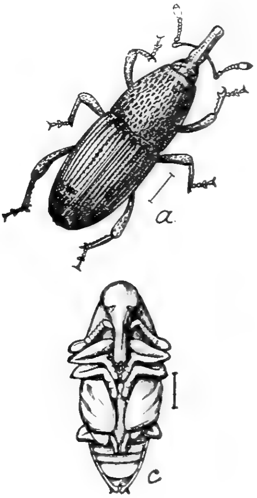

FIG. 5.

Figs. 1 and 2 are from Smith's Economic Eutomology.
Figs. 3, 4 and 5 are from publications of the U. S. Department of Agriculture.

mens were received the last of May, and the buds were dead and the insects gone. The trees were in grounds in Farmington, and the effect on them was quite noticeable. We have never seen the work of such an insect in the forests of Maine. This was probably the work of a small moth. We call attention to it as we do not know the insect and will be pleased to receive specimens of the buds with the worms in them. They should be looked for early in May. Mrs. Jaques informs us that she saw small worms emerging from the holes earlier in the season than the date of sending the buds.

THE BROWN-TAIL MOTH, an insect from Europe that has secured a foothold in Massachusetts and is claiming the attention of the Gipsey Moth Commission as a bad insect, is said to have been found in Maine, as indicated by the following letter from Mr. Sessions, the secretary.

"We are now making an inspection of the territory infested with our new imported pest, the brown-tail moth (*Euproctis chryssorrhoea*). Our inspector in discharge of his duty called on Dr. Geo. E. Osgood of 283 Highland Avenue, Somerville. The doctor is one of the reliable physicians of Somerville. His place is infested with the moth. He said that he saw the brown-tail moth in South Berwick, Maine, while on his last summer's vacation, and was sure that it was identical with the Somerville pest. He also said that while he was in South Berwick he professionally treated two cases of poisoning by contract with the moth and that the symptoms of the patients were identical with those of his Somerville patients who had been poisoned by the brown-tail moth. The premises in South Berwick are owned by the doctor's father-in-law, Andrew Whitehouse, 10 Goodwin St., South Berwick. I send you notice, that you may take such measures as you think proper in the case. I cannot of course vouch for the doctor's judgment in the matter. The caterpillars he saw in South Berwick may be something else, but I give it to you as I had it from our inspector."

We wrote Mr. Whitehouse for specimens, but he was not able to send any. We will investigate the matter next season.

THE FICKLE MIDGE (*Sciara inconstans*, Fitch) was reported by Mrs. R. S. Warren, of South Deer Isle, as eating roots and penetrating the bulbs of *Gloxinia* plants. So far as we know this is a new habit for this species. Specimens of the bulbs

received were channeled by the larvae. This insect will be considered in our next report.

Various species of ANTHOMYIIDS are common in Maine, attacking beets, working between and under the epidermis of the leaves, making light colored trails. Radishes, bean-seedlings and onions are often badly attacked. The Onion Maggot (*P. ceparum*) was reported as bad in Maine. We planted a bed of onion seed in our garden in Orono, and nearly every onion was attacked by this species.

Care should be taken to burn infested plants while the maggots are still in them.

THE RAIL-ROAD WORM (*Trypeta pomonella*) will probably not be so abundant, as the short apple crop gave them much less chance to multiply than usual. This insect could have been about destroyed if pains had been taken to gather the much fewer wind-falls.

THE CURRANT FLY (*Epochra Canadensis*) was more abundant than usual about Orono.

THE RICE WEEVIL (*Calandra oryzae*, L.) was reported as quite abundant in the store houses for grain of the Swan and Sibley Company, Belfast, Maine. We recommended the carbon bisulphide treatment. See fig. 4, *b* and *d*; fig. 5, *a* and *c*.

THE SPOTTED PARIA continues its novel habit of attacking the young buds of blackberries and raspberries. The past season this pest nearly ruined an acre of the above plants on the farm of Greenvill M. Foss and Son of Standish, Maine, as reported by Mr. C. S. Phinney. Experience with this insect indicates that it will not continue its depredations from year to year. See fig. 6, Expt. Sta. Rept. 1895.

FOREST INSECTS. We received a letter from Mr. Austin Cary, who has spent considerable time the past season exploring the forests of Maine, calling our attention to the depredations of a timber beetle (*Dendroctonus rufipennis*) that is doing damage to spruce timber in Maine. The study of timber insects is not only a great undertaking, but one of much importance. As it is impossible for the Station Entomologist to find time to enter upon the work, we hope that timber owners and the Forestry Commission may become interested in the matter and that the legislature will provide the funds to make the necessary investigations.

INSECTS EXAMINED IN 1897.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Centipede Species.		Several parties	Found in fruit shipped from the South.
2	Stone Fly	*Perla bicaudata*	Mrs. Sarah F. Lee, Oakland.	Larvæ under stones in streams.
3	Helgramite-Fly	*Corydalis cornuta*	A. L. Douglass, East Dixfield	The perfect insect. The larva is used for fish bait.
4	Cock's-Comb Gall	*Colapha ulmicola*	J. F. Bailey, Bradford	Galls on elm leaves.
5	Yellow-Necked Apple-Tree Caterpillar	*Datana ministra*	Wm. S. Robertson, Weld W. W. Perkins, Andover	Feeding on foliage of apple trees.
6	Currant Span Worm	*Diastictis ribearia*	Mrs. Wealthy Page, Hartland	
7	Zebra Caterpillar	*Mamestra picta*	Minot Packing Co., Mec. Falls. C. O. Brown, Etna	Eating corn silks and turnips.
8	Potato-Stalk Borer	*Gortyna nitela*	W. A. Noyes, Auburn E. C. Brown, Riverside	Boring in the pith of potato stalks.
9	White-Marked Tussock-Moth	*Notolophus leucostigma*	D. P. Boynton, Monmouth	Clusters of eggs on apple tree twigs.
10	Luna Moth	*Tropœa luna*	C. F. Kemp, White Rock	Sent for determination.
11	Io Emperor Moth	*Automeris io*	B. McAllister, Lowell	Had eaten all the leaves from the top of a pear tree.
12	Cecropia Emperor Moth	*Samia cecropia*	A. W. Farrer, Ripley	Cocoon on apple twig. See Experiment Station Report, 1894, page 111.
13	Velleda Lappet-Moth	*Tolype Velleda*	W. E. Blanchard, Cumb. Center	On apple tree.
14	Apple-Tree Tent-Caterpillar.	*Clisiocampa Americana*	C. N. Wells, Auburn C. H. Page, Winthrop	Clusters of eggs on apple tree twigs.
15	Forest Tent-Caterpillar	*Clisiocampa disstria*	C. N. Wells, Auburn W. W. Perkins, Andover	Egg clusters on apple trees.
16	Mourning Cloak Butterfly	*Euvanessa antiopa*	G. F. Rowell, Monmouth	Foliage of willows.

INSECTS EXAMINED IN 1897—CONCLUDED.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
17	Gloxinia Fly, Fickle Midge	*Sciara inconstans*, Fitch	Mrs. R. S. Warren, S. Deer Isle	Larvæ attacking the roots and bulbs of Gloxinia plants.
18	Anthomyiid		Mrs. A. M. Huston, Winn	Larva attacking bean seedlings.
19	The Onion Maggot	*Phorbia ceparum*	G. T. Allen, Haven	Larva attacking onions.
20	Bean Weevil	*Bruchus obtectus*, Say	L. H. Richards	Attacking stored beans.
21	Rice Weevil	*Calandra oryzæ*, L	Swan & Sibley Co., Belfast (per Mr. Bickford)	In grain bins in store.
22	Meal Beetle	*Tenebrio molitor*	Swan & Sibley Company	In grain bins.
23	Round-Headed Apple-Tree Borer.	*Saperda candida*	W. E. Ingersol, Epping	Attacking trunk of apple trees.
24	Spotted Paria	*Typophrus canellus gilvipes*, Dej	C. S. Phinney, Standish.	Attacking raspberries and blackberries. See Expt. Sta. Report, 1895, page 106.
25		*Obesia bimaculata*	F. L. Harvey, Orono	Attacking blackberry leaves.
26	Shot Borer	*Xyleborus pyri*, Peck	W. B. Selwood, Perry	Attacking the trunks of young apple-trees.
27	Buffalo Beetle	*Anthrenus Scrophulariæ*	P. H. Vose, Bangor—Auburn	Attacking carpets and woolen goods.
28	Maple-Tree Borer	*Plaginotus speciosus*	F. J. Libbey, Richmond	Attacking maple trees.
29	Horntail Pigeon Tremex	*Tremex Columba*	W. Stanwood, Bethel	Attacking and destroying maple trees.
30	Pear Tree Slug	*Eriocampa cerasi*	F. O. Tarbox, W. Kennebunk	Attacking foliage of pear trees.

NOTES ON PLANTS OF THE SEASON.

F. L. HARVEY.

More plants have been received at the Station for examination the past season than ever before. They have been largely weeds, forage plants and injurious fungi. Lectures upon weeds and fungi delivered before farmers meetings, newspaper articles, station bulletins on these subjects and the enactment of a seed inspection law, have awakened an interest in these pests of the farm. The following table includes those species received that are of economic importance.

WILD PEPPERGRASS (*Lepidium apetalum*, Wild.) still continues to be reported. Many samples of seed examined this season contained the seeds of this weed. Reported from Aroostook as putting up shoots after haying and maturing abundant seed by September.

SHEPHERD'S PURSE is being widely introduced with seed. It is not a very bad weed in fields, but a nuisance about gardens and lawns in Maine.

THE RED MILKWORT, though not a bad weed in Maine, has been reported as abundant in some localities in low sandy soil. It is not likely to give much trouble.

TUFTED VETCH or BLUE VETCH (*Vicia Cracca*, L.) continues to spread. Farmers are not agreed concerning it. Some regard it as a good forage plant, while others condemn it as a bad weed. It grows rank and gives a good yield per acre. The patches die in the centre and enlarge from the outside.

THE RABBIT-FOOT and HOP CLOVERS are gaining ground along highways and in waste places. If we must harbor weeds along roadsides, I know of no more attractive ones.

THE ORANGE HAWKWEED continues to be reported from new localities.

THE BRISTLY BUTTERCUP and GOLDEN RAGWEED have been mistaken for the KING-DEVIL WEED, a plant that is well established about Gardiner and vicinity and is spreading.

THE MAY-WEED (*Anthemis cotula*, L.), which follows man, has made its appearance in northern Aroostook County.

In the seeds examined this season we have frequently found the seeds of SOW THISTLES, and these weeds are widely distributed in the State. *Sonchus arvensis* is reported from Aroostook County as overrunning potato fields and choking out grass in newly seeded fields. Sow Thistles will not persist in grass lands, but they become a nuisance in gardens and fields.

THE COMMON MILKWEED (*Asclepias cornuti*, Des.) is regarded as a bad weed in low mowing fields in southwestern Maine.

THE ARISTATE PLANTAIN is widely distributed in newly sowed land. It does not seem to persist much after the first season. The seeds of its relative, the *English Plantain*, are quite abundant in clover seed from the West.

THE THREE-SEEDED MERCURY (*Acalypha Virginica*) has been reported as a bad weed in gardens and also as spreading to fields. It ought to yield readily to clean culture.

THORNY AMARANTHUS OR PIGWEED is a bad weed in gardens and cultivated land. It has the disagreeable habit of growing rapidly after hoed crops are laid by and makes large growth, seeding profusely before frost. The seeds are very common in grass seed sold in Maine.

SQUIRREL-TAIL GRASS (*Hordeum jubatum*) is becoming common in western Maine. It is a bad weed. It springs up in car yards where western grain is unloaded and will spread to farms.

THE POTATO BLIGHT (*P. infestans*) was very prevalent throughout the State. Potatoes rotted badly. Never before has the value of spraying been so emphasized. Fields where spraying was done yielded a good crop of sound tubers, while adjoining fields that were not sprayed were almost a failure.

THE STRAWBERRY LEAF BLIGHT continues to do damage. This has been quite successfully treated by spraying on the Experiment Station grounds.

THE QUINCE RUST continues to give trouble in southwestern Maine, attacking pear trees. A row of *Amalanchier* bushes in the Experiment Station grounds was badly attacked, nearly every fruit being infected. It is very difficult to explain the infection of a whole patch upon any other theory than that the disease is perennial.

BLIGHTING OF MAPLE LEAVES.

Last spring we received specimens of maple leaves from several sources that were turned brown, as though injured by insects or fungi or by frost. We noticed that maple trees about Orono were similiarly affected. A careful examination of the leaves eliminated insects and fungi as the cause of the trouble, and as the temperature did not reach the freezing point at the time the leaves turned brown, this cause was also discarded.

The effect was produced in a day. The leaves were rapidly unfolding and were nearly expanded. Following warm, moist weather there came a dry hot wind, which evaporated the moisture from the tender young foliage faster than it could be restored, causing the leaves to turn brown.

STINKHORN FUNGI.

We frequently receive specimens or inquiries regarding these offensive fungi and presume a short account of them will be interesting. We have found three species growing in Maine, belonging to the genera *Phallus* and *Mutinus*.

These fungi at first are nearly spherical and look like puff balls. They finally burst open irregularly and the hollow stem is pushed through, bearing at its top a conical cap. The stem is sometimes naked, or it may be surrounded by a porous membrane called the veil. The cap is conical and may be loosely attached at the apex of the stem or grown to it the whole length. It may be wrinkled on the outside or smooth. There is usually a hole at the top of the cap, though it is not always present. There is borne on the outside of the cap a greenish jelly-like mass containing the greenish spores. It is this greenish matter that is so offensive. The presence of these fungi gives the impression that an animal has died and is undergoing decomposition and the true cause is usually overlooked. The accompanying figures will enable anyone to determine these plants when seen. They should be burned or buried.

Phallus daemonum, Rumple. This species grows in rich soil about gardens and in the woods. Seems to prefer decaying wood. We have found it about the mill yards where bark and sawdust were decomposing; also in pastures about decaying

stumps. The specimen figured was one of a cluster of about a dozen found by Artemus Rigby, Stillwater, Maine, growing in rich soil in his garden. This species has a veil around the stem, the surface of the cap is wrinkled and pitted and there is a hole at the top of the cap, surrounded by a whitish smooth ring. See fig. 1.

Phallus impudicus, Linn. This is not so common. We have specimens from central Maine found growing about the exit of a sink spout.

This species is fully as large as the other, six or eight inches high. It may be distinguished by not having a veil, by the cap being smoother on the outside, with no rim around the hole at the apex. See fig. 2.

Mutinus brevis, B. & C. This is much smaller. Not over three or four inches high, slender, pink and with the cap grown to the stem the whole length. This is the most common species. We have found it every season for the last twelve years on the ground in a clump of low lilac bushes growing near a barn. All three of the above species are very offensive. There are probably other species of the family in the State and we will be pleased to receive specimens. They can be put in fifty per cent alcohol and forwarded by express.

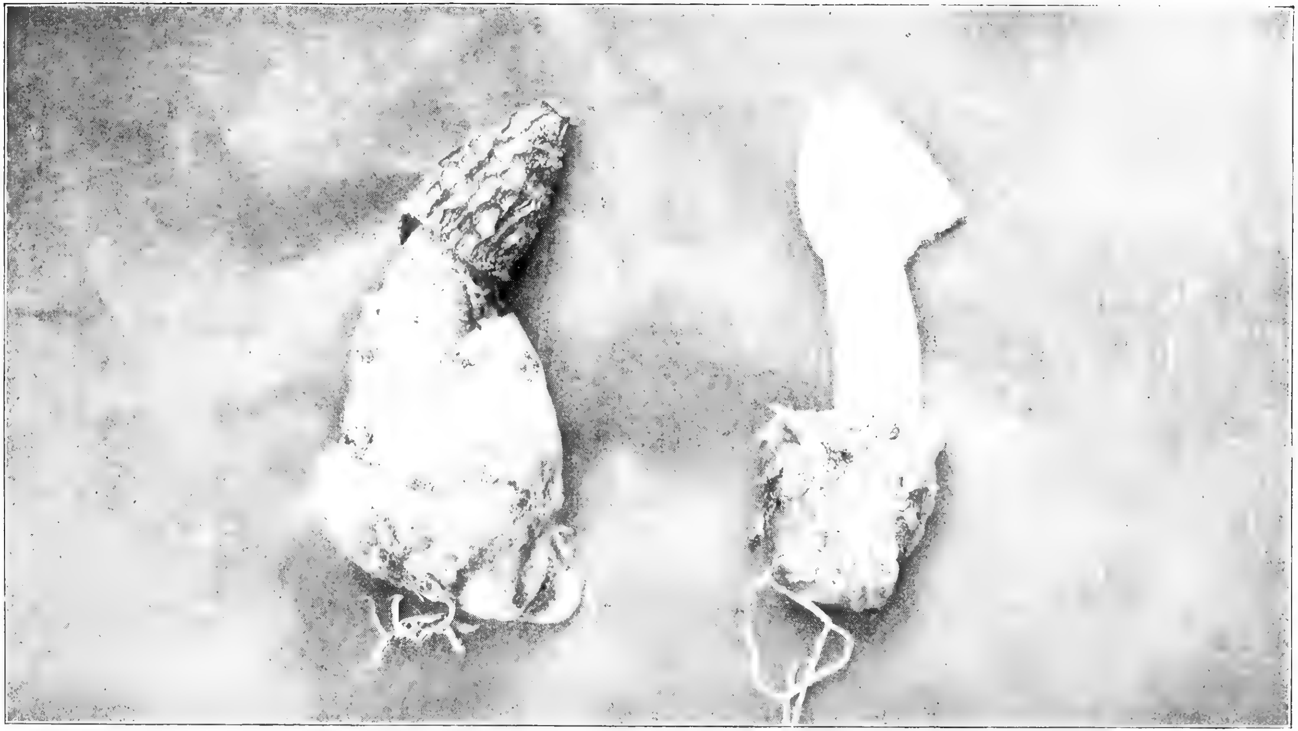

Fig 1. Fig. 2.

STINKHORN FUNGI.

PLANTS EXAMINED IN 1897.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Bristly Buttercup	*Ranunculus Pennsylvanicus*, L. f.		Mistaken for King-Devil Weed.
2	Apetalous Peppergrass	*Lepidium apetalum*, Willd.	V. T. Lundvall, New Sweden. S. W. Tabor, Washburn. E. T. Perkins, Saco. J. H. Hammond, Sanford. A. J. Abbott, North Paris.	Introduced with seed. Found in newly seeded land. Increasing rapidly in Maine.
3	Shepherd's Purse	*Bursa Bursa-pastoris*, (L) Brit.	D. F. Hodges, Phillips	Troublesome in gardens and grain. Introduced in western seed.
4	Night Flowering Catchfly	*Silene noctiflora*, L.	Samuel Libbey, Orono	Weed in gardens. Quite common.
5	Cheeses. Dwarf or Running Mallow	*Malva rotundifolia*, L	C. O. Brown, Etna	Weed in rich soil. Gardens and wastes.
6	Red Milkwort	*Polygala sanguinea*	W. R. Plummer, Bradford B. B. Taylor, North Fairfield.	Weed in low fields.
7	Tufted or Cow Vetch. Blue Vetch	*Vicia Cracca*, L.	G. S. Paine, Winslow C. O. Brown, Etna. Wm. Haskell, Hodgden.	Weed in grass lands. Increasing. This is a native plant.
8	Yellow or Hop Clover	*Trifolium agrarium*, L	S. Milliken, West Scarboro. J. H. Hammond, Sanford.	Growing with white clover in field.
9	Rabbit-foot Clover	*Trifolium arvense*, L	C. O. Brown, Etna	Fields and waste places.
10	Low Cudweed	*Gnaphalium uliginosum*, L.		Grain and grass fields.
11	Yellow Daisy. Coneflower	*Rudbeckia hirta*, L.	D. F. Hughes, Phillips	Newly seeded fields.
12	Daisy Fleabane	*Erigeron strigosus*, Muhl	D. F. Hodges, Phillips	Abundant in grass fields and on the increase.
13	Giant Sunflower	*Helianthus giganteus*, L	E. C. Carll, Buxton	Growing in field in bunches.
14	Mayweed	*Anthemis cotula*, L	V. T. Lundvall, New Sweden	Recently introduced.
15	Golden Ragweed	*Senecio aureus*, L.	W. M. Chandler, West Sumner	Mistaken for King-Devil Weed.
16	Star Thistle. Knapweed	*Centaurea nigra*, L.	S. Milliken, West Scarboro	Introduced in western seed.
17	Chicory	*Cichorium Intybus*, L	L. E. Moore, Sebec	Weed in newly seeded fields.
18	Orange Hawkweed	*Hieracium aurantiacum*, L	J. M. Drury, Livermore Center	Recently introduced in mowing field.

PLANTS EXAMINED IN 1897—CONCLUDED.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
19	King-Devil Weed	*Hieracium prœaltum*, Vill	G. S. Paine, Winslow	Growing in mowing fields and spreading rapidly.
20	Field Sow Thistle	*Sonchus arvensis*	V. T. Lundvall, New Sweden	Mistaken for Orange Hawkweed. Bad weed in potato fi'lds & newly seeded l'd
21	Common Sow Thistle	*Sonchus oleraceus*, L	J. H. Sanborn, South Dover	Weed in fields. Has spread steadily for past ten years.
22	Spring-leaved Sow Thistle	*Sonchus asper*, Vill	V. T. Lundvall, New Sweden	Weed in field.
23	Common Milkweed. Silkweed	*Asclepias Cornuti*, Decaisne	J. H. Hammond, Sanford	Bad weed in low meadows.
24	Purple Gerardia	*Gerardia purpurea*, L	J. D. Bragg, North Sidney	Weed in pasture lands.
25	Yellow Rattle	*Rhinanthus Crista-galli*, L	B. W. McKeen, Roque Bluff	A bad weed in pastures and fields along the coast.
26	Aristate Plantain	*Plantago Patagonica aristata*, Gray	Miss L. O. Eaton, S. Chesterville.	Weed in new mowing fields.
27	Thorny Amaranthus. Pigweed	*Amaranthus spinosus*, L	G. S. Paine, Winslow	Garden and fields.
28	Three-seeded Mercury	*Acalypha Virginica*	Wm. Downs, South Sebec	In garden. Spreading to grass land.
29	Crab-grass. Five finger	*Panicum sanguinale*, L.	G. M. Twitchell, Augusta	Gardens and cultivated land.
30	Meadow Foxtail	*Alopecurus pratensis*, L	B. W. McKeen, Sedgwick and Machias	Growing in low meadows. Good for pastures.
31	Forked Beard-grass	*Andropogon furcatus*, Muhl	G. S. Paine, Winslow	In old fields and pastures with sandy soil.
32	Beard-grass	*Andropogon scoparius*, Alex.	G. S. Paine, Winslow	
33	Squirrel-tail Grass	*Hordeum jubatum*, L	E. C. Carll, Buxton	Where western grain was unloaded.
34	Black or Hair Mold	*Phycomyces nitens*	T. S. Bowden, Washington.	Growing on oily substances.
35	Potato Blight	*Phytophthora infestans*, DeBary	Various parties	Prevalent the past season, doing much damage.
36	Strawberry Leaf Blight	*Sphœrella fragariœ*.	E. L. Miller, East Hampden	Attacking leaves of the strawberry. Detected by the dark spots on the leaves.
37	Quince Rust	*Rœstelia aurantiaca*	A. C. Fernald, North Deering	Attacking Champion quince bushes.
38	Gooseberry Rust	*Æcidium grosulariœ*	A. C. Fernald, North Deering	Cluster cups on leaves of gooseberries.
39	Stinkhorn Fungus	*Phallus dœmomum*, Rumph	Artemus Rigby, Stillwater W. F. Brown, Week's Mills.	Growing in rich soil. Emitting offensive odors.

THE KING-DEVIL WEED.

F. L. Harvey.

Hieracium praealtum, Villars.

Order Compositae; Sunflower Family.

HISTORY AND DISTRIBUTION.

This interesting plant is a native of Europe. It was first described by Dominique Villars in 1808.

When and where it was introduced into this country, or the circumstances of its introduction are entirely unknown. Mr. Lester F. Ward suggests that it may have been originally a ballast plant of some Canadian port, as Toronto, it having been collected at that place in 1894.

It was first detected in this country in 1879 by Mr. Lester F. Ward, who found it well established at Carthage and Evan's Mills, Jefferson county, New York. Since that date it has spread over a large area in northern New York, becoming a pernicious weed. On account of its bad reputation in that region, it acquired its regal-satanic name.

When it made its first appearance in Maine is not known. It was first brought to notice by Mr. H. K. Morrell, Gardiner, Maine, who found a few specimens growing in fields in West Gardiner in 1895 and reported them to the Josselyn Botanical Society of Maine. Since that date it has spread rapidly and is now found in many fields in West Gardiner, Gardiner, Farmingdale and Litchfield, adjoining towns on the west side of the Kennebec, and also at Winslow on the east side of the Kennebec, over twenty miles from the other infested area.

In June, 1897, we received the following letter from Mr. Dewey, assistant botanist at the United States Department of Agriculture: "I received yesterday from Mr. H. K. Morrell, Gardiner, Maine, specimens of devil weed, *Hieracium praealtum.*

Mr. Morrell states that some fields in the vicinity of Farmingdale are full of this weed. The farmers of that vicinity should be warned of its dangerous character and an effort should be made to eradicate the plant if possible before it becomes more widely distributed. This weed proved very troublesome in northern New York where it is regarded as even worse than the orange hawkweed, *(Hieracium aurantiacum)*."

Although we were aware that this pest had been reported from Gardiner, it was thought advisable to visit the region and learn from personal observation the distribution and habits of the plant.

On June 27, 1897, in company with Mr. Morrell, we examined a part of the infested district and found the pest surprisingly abundant, growing in large patches and as scattering plants in many fields. We informed all the farmers we met of the pernicious nature of the weed and the importance of destroying it. We were surprised at the apathy of farmers regarding the introduction and spread of this bad weed. There are always individuals who are alive to the importance of keeping fields clean and who make desperate efforts to do so, but are hampered and discouraged by their indolent neighbors, whose farms are centres for the growth and distribution of all the bad weeds in the region. So far as we know, no concerted action has been taken to eradicate this pest. We see more and more the necessity of State action in such cases. Unless some definite action is soon taken, we may expect that this weed will overrun the State like its detestable relative, the Orange Hawkweed.

Below we give a record of the known North American localities of the King-Devil Weed.

RECORD.

Carthage, Jefferson county, New York, L. F. Ward, 1879.

Evans' Mills, Jefferson county, New York, L. F. Ward, 1879.

Pierpont Manor, Jefferson county, New York, C. H. Peck, 1893.

Jayville, St. Lawrence county, New York, C. H. Peck, 1893.

Ogdensburg, St. Lawrence county, New York, J. E. DuBois, 1894.

Denmark, Lewis county, New York, specimen in Nat. Herb., 1894.

Toronto, Canada, specimen in Nat. Herb., 1894.

Locust Grove, Lewis county, New York, Helen M. Bagg, 1896.

Maine Localities.

Farmingdale, Maine, Bowman St., Farm of C. R. Glidden, H. K. Morrell, 1895.

West Gardiner, Kennebec county, H. K. Morrell, 1895.

Gardiner, Kennebec county, H. K. Morrell, 1896.

Litchfield, Kennebec county, H. K. Morrell, 1896.

Winslow, Kennebec county, G. S. Paine, 1897.

DESCRIPTION.

Root perennial, multiple,—fibrous.

Stems 2 feet or more high, 1 to 4 or 5 from the same root. The central one erect, the others smaller and more or less declined, purplish below, clothed with whitish, bristly hairs, that are dark colored at the base. The hairs are more numerous toward the base of the plant, mixed in the upper part of the stem with glandular hairs, dark colored, shorter, which become abundant on the flower pedicels and involucre. Mr. Ward and also Dr. Gray describe the upper part of the plant as free from hairs, but our specimens show scattered hairs the whole length of the stem and they are also mixed with the glandular hairs on the flower pedicels and on the scales of the involucre. Spreading by means of stolons as shown in the plate and also by root-stocks which connect different plants below ground.

Leaves lanceolate with a winged petiole, margin more or less wavy with scattered small, dark-colored teeth. Pale green both sides and armed above and below with scattering long, white hairs, which show a dark base on the mid ribs, and sometimes on the other parts. Radical leaves many, making a dense mat on the ground in the patches. Stem leaves smaller, narrower, 2 to 4, located on the radical half.

Infloresence paniculate or cymose. On the larger plants with many heads; those on the lower pedicels open first, and when the pedicels branch, the lower heads on the branches are

the first to bloom, making the infloresence indeterminate and paniculate. On the smaller flower shoots of the larger plants, on the smaller flower clusters that come out lower, on plants that branch, and on small plants with few heads; the terminal head opens first making the infloresence determinate and cymose. Dr. Gray says the infloresence is open cymose, probably determined from a small plant with few heads.

Mr. Ward says paniculate, probably from the examination of larger plants with many heads. Flower clusters terminal, and if branched, terminal on the branches, composed of from 4 to 25 heads, each about one-half inch long. Flowers 50 or more in each head. Yellow corollas strap-shaped and extending beyond the involucre about its length. Involucre green, one-fourth inch long, composed of many narrow, pointed, hairy scales in a single row. Achenes 2 mm. long, dark reddish-brown, about ten-ribbed, oblong, truncate above and gradually narrowing to the obtuse base. Slightly flattened below. Pappus 4 mm. long, composed of a single series of delicate, whitish bristles, which under high powers are plumose with short hairs.

HABITS.

The plants grow in grass lands, cultivated fields and along roadsides. The seeds germinate in the fall and the young seedlings live over winter and continue to live from year to year. The plants increase by stolons and rootstocks. Flowering stems are put up early in the summer and the plants are in full bloom and many of the heads fully ripe the last of June in Maine.

Mr. Dewey in Farmer's Bulletin No. 28, U. S. Department of Agriculture, p. 25, gives the time of flowering in New York as from June to September, and the time of seeding from August to October. The plant is fully a month earlier in Maine and becomes a nuisance, as its seeds are ripe before the grass is ready to cut. Plants that were shedding seed from some of the heads the last of June, bore small buds just forming, making the period of seed maturation quite long.

Many plants are tardy in putting up flower stems, so that flowering continues all summer. Plants cut off by mowing the grass put out full flowering stems that mature seed before frost.

The plants make patches and the root leaves mat the ground so thoroughly that nothing else will grow. The seeds (achenes) are provided with numerous bristles (pappus), making them light, and slight winds scatter them far and wide.

This pest seems to flourish in Maine soil and is rapidly spreading. We saw many plants that were considerably over two feet high and some of them put up several stems from the same root. Since 1893 it has spread more than the Orange Hawkweed has in the same region for twenty years. It will take root in mowing fields that have not been plowed for ten years. It blooms about the same time as the Tall Buttercup (R. acris) and the flowers being of nearly the same shade of yellow it is difficult to detect it when they are growing in grass lands together.

It can be distinguished from the Orange Hawkweed by having yellow instead of reddish-orange blossoms, and by the smaller and usually more numerous heads. From our native hawkweeds by the flowers being closely clustered at the top of the few leaved stem. From another introduced hawkweed that is found about Sangerville, Maine, and sparingly at Orono, by its larger size and the fact that this species has only one or two larger heads at the top of the stem. From the Fall Dandelion by the form of the leaves and earlier flowering.

REMEDIES.

We have had no experience with this weed. Its nature and habits are similar to those of the Orange Hawkweed and it would no doubt yield to the same treatment.

Five methods of treating Orange Hawkweed have been suggested:

I. Watch the fields carefully each season and pull or carefully dig the scattering plants that make their appearance, not allowing them to seed or spread.

II. Turn the infested field and cultivate carefully some hoed crop until the weed is eradicated.

III. Crop the turned field heavily with some strong growing plant to choke out the weed.

IV. Convert the infested field into a sheep pasture until the weed is destroyed.

V. Apply salt to single plants, to patches, or to whole fields when badly infested. It should be applied dry, sown broadcast, so as to reach all the leaves, at the rate of 18 pounds to the square rod, a ton and a half to the acre.

Remedy I is preventive and we regard it the best, not only for this weed but as a settled policy for coping with all kinds of weeds. When the plants are few they can be destroyed without much loss of time, or expense. It is poor policy to wait until fields are overrun and then be compelled to turn or salt them at great expense. The safest way to fight a weed is not to allow it to get a foothold. Our farmers should be on the alert and when a strange plant appears in the fields it should claim immediate attention, its name and habits should be determined, and remedial measures at once adopted.

In digging scattering plants of hawkweed it should be remembered that they put out underground stems, and care should be taken not to leave these in the ground to start new plants. The fields should be examined later for any plants that may have been overlooked, or start from stolons.

The Orange Hawkweed in Maine grows along roadsides, in orchards and in rocky pastures where it is undesirable, or impossible to plow, and the only remedy available is to carefully examine such places every year for scattering plants and thus control the spread. If established, apply salt as suggested in remedy V.

Whether the King-Devil Weed will spread to pastures, we do not know. In New York it grew along roadsides, and in Maine the plant established itself in a mowing field that had not been plowed for ten years.

Method II recommends itself when there is no reason why the field may not be turned and cultivated in a hoed crop. It is a worthless method without clean culture and the exercise of care that scattering plants on other parts of the farm are destroyed and not allowed to mature and reseed the field. This method was tried the past season on the University of Maine farm for the Orange Hawkweed and was apparently successful.

Professor L. R. Jones of the Vermont Experiment Station has experimented largely with salt for the Orange Hawkweed and claims that it will destroy it and prove beneficial to the

KING-DEVIL WEED.

grass, nearly doubling the yield. Professor Jones says salt suitable for this purpose can be obtained for from $3 to $5.50 per ton. The expense seems large, but if the application will double the hay crop, as Professor Jones says, the increased yield would balance the outlay.

This method has never been applied for the Orange Hawkweed or King-Devil Weed in Maine, but Mr. Ward records the use of salt to destroy the latter in northern New York and does not speak flatteringly of the results.

Those who are interested in the details of Professor Jones' experiments can consult Bulletin of the Vermont Experiment Station No. 56, 1897.

The plate, prepared from a photograph, shows a specimen that was two and a half feet high, reduced in reproduction. The habit of increase by stolons is shown.

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HERD RECORDS.

G. M. Gowell.

These statements are published to show the individuality of cows as milk and butter producers, and to add to the limited data, so far accumulated, bearing upon: the ratio of the decrease of milk flow, from the time the cow is fresh until she is dry; the changes of the per cent of fat from month to month; and the milk and fat yields during the months following the act of breeding.

On January 1, 1897, there were fourteen cows in the station herd. Several others were purchased later in the season, but their records are not included here, as they were in the herd but part of the year.

The animals have been fed as nearly in accordance with their individual requirements as we have been able to determine. All have received about the same quantities of succulent foods—silage, turnips, and pasturage. The hay and grain have been varied in quantity and kind, as different animals seemed to require at different times. In the main, the grain mixture has consisted of about equal parts by weight of wheat bran, corn meal, and gluten meal, fed at all seasons of the year, while the cows were in milk. Small quantities of linseed meal, cotton seed meal and feed flour have been used. When dry, wheat bran has been the only grain feed. The hay was mixed timothy, redtop and Alaska clover, grown upon the farm. The silage was of Sanford corn—eighty tons having been cut into the silo from three acres of land, when it was in the early dough condition. It would have been allowed to mature further, but for the fear of frost. The turnips were rutabagas, fed until the last of December, to cows in milk just after milking in the morning, and to the dry cows at noon. During July, August, and September, pasture was supplemented by green hay, green

oats, and peas or sweet corn fed in the barn, night and morning as needed.

While confined in the barn, from October first to June first, they were watered twice each day. The milking was commenced at six o'clock in the mornings during winter, and in summer at half past five. The afternoon milking was commenced at half past three o'clock throughout the year. This early afternoon milking was necessary so that the milk might be delivered to the consumers at half past five o'clock. Our experience here causes us to believe that these unequal periods of time between milkings are not detrimental to the milk yield. The cows become accustomed to the arrangements, and being largely creatures of habit they continue to secrete and yield milk as freely as though the periods were more nearly equal.

These animals are valuable for breeding purposes and our aim is to develop their ability to produce satisfactorily. This we do by careful handling and feeding. Coarse and succulent foods are provided them freely, while moderate quantities of concentrated foods are used. Larger yields of milk and butter could easily have been secured by heavier grain feeding.

ROSE.—No. 1802 Maine State Jersey Herd Book. Ten years old. Calved September 15, 1896, and November 16, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	716.7	5.1	36.55	42.64
February	610.7	5.1	31.14	36.23
March	601.0	5.0	30.05	35.06
April	584.3	4.9	28.63	33.40
May	598.4	4.0	23.93	27.91
June	586.5	4.9	28.73	33.52
July	567.3	4.7	26.66	31.10
August	555.3	4.8	26.65	31.09
September	510.6	4.3	21.95	25.61
October	280.9	4.4	12.35	14.41
November	323.7	4.3	13.91	16.23
December	574.2	4.6	26.41	30.81
	6509.6		306.96	358.01

Food consumed, 4,600 pounds hay	$23 00	
3,400 pounds grain	25 50	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$63 00

Cost of food for each pound of milk .... .97 cents.

Cost of food for each pound of butter .... 17.59 cents.

ADDIE S.—No. 2383 Maine State Jersey Herd Book. Eight years old. Calved September 10, 1896, and October 8, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	703.0	5.3	37.26	43.47
February	575.1	5.2	29.90	34.88
March	534.7	5.5	29.40	34.30
April	464.1	5.0	23.20	27.06
May	452.4	4.0	18.09	21.10
June	465.1	5.0	23.25	27.12
July	262.7	4.7	12.34	14.39
August	162.6	4.9	3.06	3.57
September	12.5	5.0	.62	.72
October	680.9	4.6	31.32	36.54
November	859.2	4.8	41.24	48.11
December	692.6	4.3	29.78	34.72
	5864.9		279.46	326.00

Food consumed, 4,200 pounds hay	$21 00	
3,100 pounds grain	23 25	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$58 75

Cost of food for each pound of milk .... 1.00 cents.

Cost of food for each pound of butter .... 18.02 cents.

HOPE.—No. 2368 Maine State Jersey Herd Book. Six years old. Calved October 1, 1896 and October 28, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	504.1	5.7	28.73	33.52
February	440.5	5.6	24.66	28.77
March	450.0	5.0	22.50	26.25
April	399.2	5.4	21.55	25.14
May	400.2	5.2	20.81	24.28
June	342.5	5.5	18.83	21.97
July	333.8	5.5	18.35	21.41
August	292.5	5.7	16.77	19.56
September	91.4	5.7	5.20	6.07
October	....	....	....	....
November	719.2	3.8	27.33	31.88
December	657.5	5.0	32.87	38.35
	4630.9		2376.0	277.20

Food consumed, 4,200 pounds hay	$21 00	
3,000 pounds grain	22 50	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$58 00
Cost of food for each pound of milk	1.25 cents.	
Cost of food for each pound of butter	20.92 cents.	

TULIP.—No. 2501 Maine State Jersey Herd Book. Five years old. Calved February 3, 1897. Took sudden cold and went dry September 30, 1897. Calved again January 31, 1898 in perfect condition.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	....	....	....	....
February	752.8	6.0	45.16	52.68
March	915.1	5.2	47.61	55.54
April	826.4	5.5	45.45	53.02
May	788.9	5.0	39.44	46.01
June	759.3	5.6	42.52	49.60
July	692.9	5.0	34.64	40.41
August	639.6	5.0	31.98	37.31
September	601.2	5.0	30.06	35.07
October	....	....	....	....
November	....	....	....	....
December	....	....	....	....
	5976.7		316.86	369.64

Food consumed, 4,600 pounds hay	$23 00	
2,200 pounds grain	16 50	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$54 00
Cost of food for each pound of milk	.92 cents.	
Cost of food for each pound of butter	14 61 cents.	

RUTH.—No. 2369 Maine State Jersey Herd Book. Five years old. Calved October 2, 1896 and December 4, 1897.

1897.	Milk —lbs.	Test —%	Fat —lbs.	Butter —lbs.
January	650.3	4.8	30.21	35.24
February	562.6	4.7	26.44	30.84
March	621.1	5.0	31.05	36.22
April	566.5	4.6	26.05	30.39
May	577.1	4.9	28.27	32.98
June	581.7	5.3	30.83	35.97
July	534.2	6.3	33.69	39.30
August	472.3	5.6	26.44	30.84
September	432.0	4.8	20.73	24.18
October	280.2	4.8	13.44	15.68
November	21.6	4.9	1.05	1.22
December	595.6	4.2	25.01	29.18
	5,895.2		293.21	342.04

Food consumed, 4,200 pounds hay	$21 00	
2,800 pounds grain	21 00	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$56 50

Cost of food for each pound of milk .95 cents.
Cost of food for each pound of butter 16.37 cents.

LOTTIE.—No. 1751 Maine State Jersey Herd Book. Ten years old. Calved October 31, 1896. Due to calve September 29, 1898.

1897.	Milk —lbs.	Test —%	Fat —lbs.	Butter —lbs.
January	800.1	6.0	48.01	56.07
February	666.4	6.0	39.98	46.64
March	619.1	6.0	37.14	43.33
April	547.6	5.6	31.65	36.92
May	546.1	5.6	30.58	35.67
June	554.1	5.8	32.13	37.48
July	516.0	5.6	28.89	33.70
August	579.2	5.5	31.85	37.16
September	591.5	5.0	29.57	34.50
October	511.9	5.6	28.66	33.43
November	366.1	5.7	20.86	24.50
December	309.8	6.2	19.20	22.40
	6,607.9		378.52	441.80

Food consumed, 3,800 pounds hay	$19 00	
3,200 pounds grain	24 00	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$57 50

Cost of food for each pound of milk .87 cents.
Cost of food for each pound of butter 13.01 cents.

ORLETTA. No. 1734 Maine State Jersey Herd Book. Ten years old. Calved October 15, 1896, and November 6, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	560.8	5.1	28.60	33.66
February	496.9	5.0	24.84	28.98
March	543.1	5.3	28.78	33.57
April	522.0	4.9	25.57	29.83
May	560.2	4.6	25.76	30.05
June	551.6	4.8	26.47	30.88
July	501.7	5.2	26.08	30.42
August	419.9	5.6	23.51	27.43
September	203.0	5.7	11.58	13.50
October	....	....	....	....
November	597.6	4.6	27.48	32.06
December	692.2	4.6	31.84	37.14
	5649.0		280.51	327.52

Food consumed, 3,800 pounds hay	$19 00	
3,000 pounds grain	22 50	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$56 00
Cost of food for each pound of milk		.99 cents.
Cost of food for each pound of butter		17.09 cents.

DUDLEY—Jersey, high grade. Seven years old. Calved November 1, 1896, and July 27, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	648.5	5.3	34.37	40.10
February	591.4	5.4	31.93	37.35
March	605.3	5.1	30.87	36.01
April	487.4	5.1	24.85	28.99
May	485.3	5.0	24.26	28.30
June	355.8	5.4	19.21	22.41
July	18.8	3.9	.73	.85
August	720.0	4.0	28.80	33.60
September	754.8	3.8	28.68	33.46
October	787.0	4.2	33.05	38.56
November	564.4	4.9	27.65	32.26
December	514.3	4.9	25.20	29.40
	6533.0		309.60	361.29

Food consumed, 3,800 pounds hay	$19 00	
2,900 pounds grain	21 75	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$55 25
Cost of food for each pound of milk		.84 cents.
Cost of food for each pound of butter		15.29 cents.

PANSY.—Jersey, not registered. Seven years old. Calved March, 1896, and April 13, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	550.2	5.9	31.46	36.70
February	420.0	5.8	24.36	28.42
March	372.9	6.2	23.11	26.91
April	268.3	3.5	9.39	10.93
May	719.3	3.5	25.17	29.36
June	627.6	5.0	33.63	39.23
July	643.6	4.8	30.89	36.04
August	644.9	5.2	33.53	39.12
September	534.2	4.8	25.64	29.91
October	488.1	5.4	26.35	30.74
November	413.1	5.7	23.54	27.46
December	313.7	6.0	18.82	21.96
	6040.9		305.89	356.78

Food consumed, 4,200 pounds hay	$21 00	
3,100 pounds grain	23 25	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$58 75
Cost of food for each pound of milk		.97 cents.
Cost of food for each pound of butter		16.46 cents.

ADLE.—Jersey, high grade. Four years old. Calved May, 1896, and April 26, 1897

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	495.4	6.6	32.71	38.16
February	387.0	6.8	26.32	30.70
March	251.7	7.7	19.71	22.99
April	55.7	7.6	4.23	4.93
May	652.7	5.1	33.28	38.82
June	709.3	5.8	41.14	47.99
July	675.9	5.4	36.49	42.57
August	682.1	5.6	38.19	44.55
September	553.7	5.0	27.68	32.29
October	597.2	5.3	31.65	36.92
November	401.1	5.4	21.65	25.26
December	330.9	5.9	19.52	22.72
	5792.7		332.57	387.90

Food consumed, 4,600 pounds hay	$23 00	
3,300 pounds grain	24 75	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$62 25
Cost of food for each pound of milk		1.07 cents.
Cost of food for each pound of butter		16.30 cents.

TURNER—Jersey, high grade. Seven years old. Calved November 1, 1896, and October 21, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter. —lbs.
January	706.1	4.7	33.18	38.71
February	553.6	4.8	26.57	31.00
March	528.2	4.7	24.82	28.98
April	531.2	4.2	22.31	26.03
May	563.1	4.2	23.65	27.59
June	543.4	4.4	23.90	27.86
July	453.1	4.8	21.74	25.36
August	401.3	4.6	18.45	21.52
September	202.7	4.8	9.72	11.34
October	129.4	3.8	5.91	6.88
November	778.0	3.5	27.23	31.77
December	646.0	4.4	28.42	33.15
	6046.1		265.90	310.19

Food consumed, 4,200 pounds hay	$21 00	
2,900 pounds grain	21 75	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$57 25

Cost of food for each pound of milk	.94 cents.
Cost of food for each pound of butter	18.45 cents.

MADALINE—Holstein and Jersey. Eight years old. Calved February 23, 1897. Due to calve April 1, 1898.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter. —lbs.
January	....	....	....	....
February	194.9	5.4	10.52	12.27
March	1028.4	4.6	47.29	55.16
April	1108.3	4.2	46.55	54.31
May	975.1	4.2	40.95	47.77
June	878.6	4.0	35.02	40.85
July	839.6	4.0	33.58	39.18
August	824.7	3.8	31.32	36.54
September	747.0	3.9	29.13	33.98
October	587.8	4.2	24.68	28.79
November	354.2	4.5	15.93	18.56
December	177.3	4.5	7.97	9.30
	7715.9		322.94	376.73

Food consumed, 4,200 pounds hay	$21 00	
3,400 pounds grain	25 50	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$61 00

Cost of food for each pound of milk	.79 cents.
Cost of food for each pound of butter	16.19 cents.

FATAMIE—Holstein. Seven years old. Calved March 9, 1897. Due to calve May 19, 1898.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	....	....	....	....
February	....	....	....	....
March	905.1	3.8	34.39	40.12
April	1094.7	3.5	38.31	44.69
May	925.6	3.4	31.47	36.61
June	764.4	3.4	25.98	30.31
July	811.6	3.6	29.21	34.07
August	851.5	3.6	30.65	35.76
September	678.0	3.2	21.69	25.30
October	644.7	3.3	21.27	24.81
November	567.6	3.4	19.29	22.50
December	415.0	3.6	14.94	17.43
	7658.2		267.20	311.60

Food consumed, 3,800 pounds hay	$19 00	
2,900 pounds grain	21 75	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$55 25

Cost of food for each pound of milk	.72 cents.
Cost of food for each pound of butter	20.3 cents.

LOBLITOP.—No. 1874 Maine State Jersey Herd Book. Ten years old. Calved September 1, 1896, and October 14, 1897.

1897.	Milk —lbs.	Test —%.	Fat —lbs.	Butter —lbs.
January	681.5	4.6	31.35	36.13
February	619.8	4.6	28.51	33.26
March	618.0	5.0	30.90	36.05
April	636.5	4.3	27.37	31.93
May	671.8	4.2	28.21	32.91
June	712.5	4.8	34.20	39.90
July	643.3	4.8	30.87	36.01
August	559.3	4.7	26.28	30.66
September	419.2	3.9	16.34	19.06
October	268.6	3.0	8.05	9.39
November	596.2	3.1	18.48	21.56
December	533.4	4.0	21.33	24.88
	6960.1		302.89	351.74

Food consumed, 4,20C pounds hay	$21 00	
3,100 pounds grain	23 25	
7,000 pounds silage	8 00	
15 bushels turnips	1 50	
Pasturage	5 00	$58 75

Cost of food for each pound of milk	.84 cents.
Cost of food for each pound of butter	16.73 cents.

METEOROLOGICAL OBSERVATIONS.

The observations summarized in the table on the following page were made by members of the station force. The instruments employed are similar to those in use by the U. S. Weather Bureau, and include: Wet and dry bulb thermometers; maximum and minimum thermometers; thermograph; rain-gauge; self recording anemometer; vane, and barometer.

Systematic observations were begun at the college in 1869. Results covering so long a period, allowing us to make comparisons with the averages for the entire period, must possess a constantly increasing value.

The season of 1897 was remarkable for the cold, backward spring. The temperature for April and May varied but little from the average. The temperature for June, however, was five degrees below that of the average for twenty-nine years. At the same time the rain-fall was considerably in excess of the usual amount, although the marked dampness was due rather to frequent than to large rain-falls, rain falling on eleven days in May, and thirteen days in June. The large number of cloudy days also contributed to this result.

The hours of observation were 7 A. M., 2 P. M. and 9 P. M. Lat. 44°, 54′, 2″, N. Long. 68°, 40′, 11″, W. Elevation above the sea, 150 feet.

METEOROLOGICAL SUMMARY FOR 1897.

Observations Made at the Maine Experiment Station.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest barometer	30.63	30.76	30.75	30.48	30.14	30.73	30.17	29.99	30.22	30.51	30.48	30.40	30.51	....
Lowest barometer	29.11	29.51	28.80	29.34	29.42	29.41	29.46	29.20	29.53	29.27	29.04	29.19	29.27	....
Mean barometer	29.86	29.86	29.86	29.87	29.80	29.74	29.83	29.71	29.90	29.95	29.84	29.85	29.84	....
Highest temperature	52	43	48	74	76	83	93	85	90	79	59	51	....	....
Lowest temperature	—18	—16	—11	14	29	30	43	41	28	19	3	11	....	....
Mean temperature	17.42	20.24	28.40	41.80	52.12	56.96	66.61	64.17	56.20	46.90	33.79	23.33	42.46	....
Mean temperature for 20 years	16.08	19.16	27.47	40.20	52.36	62.00	66.88	64.91	56.98	45.63	34.14	21.21	42.34	....
Total precipitation	3.03	2.38	3.96	3.03	4.49	3.71	2.02	5.00	2.65	1.01	5.04	3.58	......	39.90
Mean precipitation for 20 years	4.20	3.94	4.25	2.86	3.53	3.53	3.35	3.82	3.42	3.96	4.44	3.90	....	45.20
No. days with precip. of .01 inch or more	7	5	12	10	11	13	9	6	7	3	8	10	....	101
Snow fall in inches	23.2	9.5	6.5	....	....	....	....	....	....	....	6.0	12.8	....	58.0
Average snow fall for 20 years	22.9	21.5	16.8	6.1	0.3	....	....	....	....	1.0	7.9	17.7	....	92.4
Number of clear days	15	9	10	10	4	10	7	8	14	21	8	7	....	123
Number of fair days	6	11	9	6	12	7	11	12	10	6	8	7	....	105
Number of cloudy days	10	8	12	14	15	13	13	11	6	4	14	17	....	137
Total movement of wind in miles	5490	5678	6027	6611	6658	4932	5711	4800	5107	5766	7495	5103	....	....

REPORT OF THE TREASURER.

Maine Agricultural Experiment Station in account with the United States appropriation, 1896-7:

DR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1897, as per act of Congress approved March 2, 1897		$15,000 00

CR.

By salaries:		
(a) Director and administration officers	$2,423 28	
(b) Scientific staff	5,421 84	
(c) Assistant to scientific staff	1,160 44	
(d) Special and temporary services	11 63	
Total		$9,017 19
Labor:		
(a) Monthly employees	$967 80	
(b) Daily employees	337 44	
(c) Hourly employees	28 00	
Total		1,333 24
Publications:		
(a) For printing	$114 15	
(b) Printing annual report	168 00	
(c) For envelopes for bulletins and reports	111 20	
(d) Other expenses	129 00	
Total		522 35
Postage and stationery		312 48
Freight and express		203 33
Heat, light and water		557 35
Chemical supplies:		
(a) Chemicals	$132 62	
(b) Other supplies	124 25	
Total		256 87
Seeds, plants, and sundry supplies:		
(a) Agricultural	$28 49	
(b) Horticultural	502 51	
(c) Botanical	6 50	
(e) Miscellaneous	51 48	
Total		588 98

Fertilizers		$67 25
Feeding stuffs		450 88
Library		207 62
Tools, implements, and machinery		34 00
Furniture and fixtures		218 97
Scientific apparatus		299 40
Live stock:		
(c) Sheep	$ 9 50	
(f) Sundries	26 10	
Total		35 60
Traveling expenses:		
(a) In supervision of Station work	$148 36	
(b) In attending various meetings	106 18	
Total		254 54
Contingent expenses		16 36
Building and repairs:		
(a) New buildings	$434 86	
(b) Improvements	95 12	
(c) Repairs	93 61	
Total		623 59
Total		$15,000 00

ISAIAH K. STETSON, Treasurer.

I, the undersigned, duly appointed Auditor of the Corporation, do hereby certify that I have examined the books of the Maine Agricultural Experiment Station for the fiscal year ending June 30, 1897; that I have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements, $15,000.00; for all of which proper vouchers are on file and have been examined by me and found correct.

And I further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

ELLIOTT WOOD, Auditor.

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